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Newlan Creek
Dam, White Sulphur
Springs, Montana,
Meagher County, MT
1596

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEWLAN CREEK DAM
WHITE SULPHUR SPRINGS, MONTANA
MEAGHER COUNTY
MT 1596

prepared for:

HONORABLE TED SCHWINDEN
GOVERNOR, STATE OF MONTANA

NEWLAN CREEK WATER DISTRICT
(OWNER-OPERATOR)

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EXECUTIVE SUMMARY

Personnel of HKM Associates, under a contract with the Montana Department of Natural Resources and Conservation (DNRC), and with representation from the DNRC, the Soil Conservation Service (SCS), and the Newlan Creek Water District, inspected Newlan Creek Dam on June 26, 1980. The inspection and evaluation were performed under the authority of Public Law 92-367. Newlan Creek Dam is located on Newlan Creek, a tributary to the Smith River, approximately 6 miles north of White Sulphur Springs, Meagher County, Montana. The dam was engineered by the SCS and constructed by Rehbein Construction Company, Plains, Montana. The dam was completed in 1977. The owner is listed as being the Newlan Creek Water District even though they have not officially accepted the project.

FINDINGS AND EVALUATION

Newlan Creek Reservoir stores runoff from a drainage basin of 43.4 square miles. The basin consists primarily of rolling prairies and the foothills of the Little Belt Mountains. In terms of land use, the drainage area above the dam is approximately 56 percent forest cover and 44 percent native range, pasture and hayland. Newlan Creek Dam was built as a multipurpose project with primary benefits associated with irrigation storage, flood control, and recreation. An incidental benefit related to the storage project is sediment accumulation. Storage capacity to the principal spillway crest (elevation 5272.5 feet NGVD) is estimated to be 12,230 acre-feet (AF). Total estimated capacity to the first overtopping dam crest elevation (5282.4 feet NGVD) is 15,600 AF. The dam has a hydraulic height of 128 feet. On the basis of criteria in the U.S. Army Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams (Ref. 1), the project is large in size. There are at least three inhabitable structures, agricultural land, private utilities, and private and county roads located downstream of the dam. The downstream hazard potential is therefore high (Category 1). However, no dam breach analysis or routing of breach floods was made for the area downstream of Newlan Creek Dam. The conclusions on probable damage are based on a brief field inspection and engineering judgment.

The guidelines recommend that the discharge and/or storage capacity of a large-size, high downstream hazard potential dam be capable of safely handling the full Probable Maximum Flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region. The estimated PMF, developed during this dam safety analysis for Newlan Creek Dam, has a peak discharge of 100,900 cubic feet per second (cfs) and a total 72-hour volume of 25,500 AF.

For the flood routing, the initial reservoir pool was assumed to be at the principal spillway crest elevation (5272.5 feet NGVD), and the outlet works was assumed closed. The outlet works assumption is considered reasonable when, as part of the normal operation plan, the outlet works passes an insignificant amount of water compared to flood flows through the spillways. Routing of the estimated PMF for Newlan Creek Dam showed that the project has the capacity of controlling a flood having ordinates approximately equal to 18 percent of the PMF hydrograph ordinates.

The total outlet works facility was not capable of being field-evaluated due to the pool level at the time of survey, and the inability to safely inspect the facility with available equipment. All valves were tested for operational capability. The operation of all gate valves in the downstream valve pit were found to be satisfactory, although there is a slight amount of seepage through the packing material on two of the valves and apparently some leakage through the 4-inch gate valve. The hydraulically operated guardian gate could not be closed completely at the time of inspection. Subsequent to the inspection, the SCS indicated that the guardian gate is completely inoperable and is now blocked and chained open to allow for irrigation releases.

The principal spillway recently underwent major repairs as a result of settlements within the embankment. The modification work was completed in 1979. At the time of the inspection, the principal spillway was in satisfactory condition. Because of the settlement damage to date, close monitoring is suggested.

On the basis of a surficial examination, the rock emergency spillway is in good physical condition. There is some soil sloughing on the terraced hillside. This sloughed material is being collected on berms above the spillway channel floor.

The Newlan Creek Dam embankment appears to be stable and in good condition. However, some questions exist relative to the design stability analysis. In particular, the phreatic surface downstream of the dam centerline is higher than that assumed during the design. Settlement within the embankment appears to be a problem. As noted above for the principal spillway, major repairs were required on the spillway chute due to embankment settlements. Additional settlements are expected, but it is anticipated that they will not be as large in magnitude. Erosion is occurring on the downstream face of the dam, but does not currently present a safety hazard. Also, soil sloughing is occurring in the unfinished outlet channel downstream of the valve control box, but is not considered a safety concern.

A comparison of report findings with inspection guidelines shows Newlan Creek Dam to have insufficient storage and/or discharge capacity to safely handle the recommended spillway design flood (SDF), which is the PMF. Because the project cannot handle one-half of the PMF, the spillway is considered seriously inadequate and the dam is considered unsafe, non-emergency according to the guidelines until the recommended actions are complete.

RECOMMENDATIONS

Due to storage between normal pool and dam crest, the present project provides a degree of flood protection to the downstream area. The intent of report recommendations is to maintain or improve project safety, if feasible, without decreasing this existing flood protection.

Immediately develop, implement, and periodically test an emergency warning plan for use in the event of dam distress. Perform the following repairs on the outlet works: determine the problem(s) with the guardian gate and make the necessary repairs; repack the gate stems for the valves where necessary to eliminate leaking; and repair/replace the 4-inch gate valve in the valve control box. Regrade the dam crest and berms on the downstream face of the dam where erosion is occurring to eliminate runoff concentrations down the face. Perform the following repairs on the principal spillway: repair concrete chipping and cracking in the drop box inlets and chute where necessary; replace the small animal guards over the drain outlets in the spillway sidewalls; and redistribute the rock riprap along the right (north) stilling basin wing wall.

Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity and modify the project as studies indicate. Reevaluate the dam embankment slope stability for the present seepage condition. Improve the operating procedure for the guardian gate controls, and provide concise and understandable operating instructions in the valve pit. Develop an active monitoring program to observe and evaluate the following features: soil sloughing on the terraced slope of the emergency spillway and at the unfinished irrigation outlet channel; movements of the principal spillway; and piezometer readings along the downstream face of the embankment for a more complete definition of the phreatic surface. Conduct periodic inspections of the project at not less than 5-year intervals by engineers experienced in dam design and construction. Include an inspection of the total length of pipe through the embankment in this program. Develop and implement a periodic maintenance plan for the dam and appurtenant structures. Prior to performing engineering studies

and remedial construction, coordinate the work with the Montana DNRC, Dam Safety Section, to insure compliance with all pertinent laws and regulations.

Mike Keene

Michael D. Keene, P.E.

MICHAEL D. KEENE

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PERTINENT DATA SUMMARY

1. General

Federal ID Number	MT 1596
Owner and Operator	Newlan Creek Water District
Purpose	Irrigation, Flood Control & Recreation
Location	Section 11, T10N, R6E, MPM; 6 miles north of White Sulphur Springs, MT
County, State	Meagher County, Montana
Watershed	Newlan Creek, tributary to the Smith River
Hazard Potential	Category 1 (High)
Size Classification	Large

2. Reservoir

Surface Area at Principal Spillway Crest Elevation 5272.5 feet NGVD	317 acres
Estimated Usable Storage to Principal Spillway Crest Elevation 5272.5 feet NGVD	12,230 acre feet
Estimated Storage to First Overtopping Dam Crest Elevation 5282.4 feet NGVD	15,600 acre feet
Total Drainage Area	43.4 square miles
Reservoir Water Surface Elevation on the Day of the Inspection	5264.5 feet NGVD

3. Principal Spillway

Crest Elevation	5272.5 feet NGVD

PERTINENT DATA SUMMARY
(Continued)

Type	Concrete chute with box inlet, and joint pool drawdown structure
Chute Width	20 feet
Spillway Capacity To First Overtopping Dam Crest Elevation 5282.4 feet NGVD	3870 cubic feet per second

4. Emergency Spillway

Crest Elevation	5278.3 feet NGVD
Type	Broad-crested rock channel
Crest Width at Control Section	65 feet
Spillway Capacity To First Overtopping Dam Crest Elevation 5282.4 feet NGVD	1390 cubic feet per second

5. Outlet Works

Guardian Gate	42-inch diameter slidegate valve, hydraulically operated
Operating Gates	Three 24-inch diameter gate valves, manually controlled
Conduit	526 feet of 42-inch diameter reinforced concrete pipe (this is main pipe section, for other pipes and transitions see the plans in Exhibit C)

PERTINENT DATA SUMMARY
(Continued)

Capacity (only one 24-inch valve is operable)

To Principal Spillway Crest Elevation 5272.5 feet NGVD	103 cubic feet per second
To Emergency Spillway Crest Elevation 5278.3 feet NGVD	106 cubic feet per second
To First Overtopping Dam Crest Elevation 5282.4 feet NGVD	108 cubic feet per second

6. Dam

Type	Zoned earth fill
Structural Height	137 feet
Hydraulic Height	128 feet
Existing First Overtopping Dam Crest Elevation	5282.4 feet NGVD
Total Crest Length	850 feet
Design Dam Crest Width	30 feet
Existing Dam Crest Width	30 feet
Design Upstream Slope	1V on 2.5H at top, 1V on 3H near top, and 1V on 3.5H for remaining distance to toe
Existing Upstream Slope	1V on 2.5H above water surface on day of the study
Design Downstream Slope	1V on 2H
Existing Downstream Slope	1V on 2H

Note:
1) All elevations based on SCS benchmark elevation 5282.99 feet National Geodetic Vertical Datum (NGVD).
2) Spillway and dam crest elevations are based on a field survey, June 26, 1980, and do not correspond to those shown on the plans due to settlement or overbuild.
3) Gates referred to as having a certain diameter may be square, but cover a round opening.

CHAPTER 1
BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority

This report summarizes the Phase I inspection and evaluation of Newlan Creek Dam. The project is owned and operated by the Newlan Creek Water District.

The National Dam Inspection Act, Public Law 92-367 dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-federal dams throughout the United States. Pursuant to that authority, the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" in Appendix D, Volume 1 of the U.S. Army Corps of Engineers' Report to the United States Congress on "National Program of Inspection of Dams" in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists highly experienced in dam safety from many federal and state agencies, professional engineering organizations and private engineering consulting firms. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive concensus of the engineering community.

Where necessary, the guidelines recommend a two-phased study procedure for investigating and evaluating existing dam conditions so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety condition of the dam

(2) based upon an evaluation of the available data and a visual inspection

(3) performed to determine if any needed emergency measures and/or if additional studies, investigations and analyses are necessary or warranted

(4) not intended to include extensive explorations, analysis, or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections,

measurements, foundation exploration and testing, material testing, hydraulic and hydrologic analyses, and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases the Corps may proceed with Phase II studies but only to the extent needed to answer serious questions relating to dam safety that cannot be answered otherwise. The two phases of investigations outlined above are intended only to evaluate project safety and do not encompass in scope the engineering required to perform design or corrective modification work. Recommendations contained in this report may be for either Phase II safety analyses or detailed design study for corrective action.

The responsibility for implementation of these Phase I recommendations rests with the owner and the State of Montana, Department of Natural Resources and Conservation (DNRC). The owner/operator is urged to contact the Montana DNRC prior to taking any action on report recommendations. It should be noted that nothing contained in the National Dam Inspection Act, and no action or failure to act under this Act, shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

The investigation process allows for report review by: the Montana DNRC; the Soil Conservation Service (SCS); and the Newlan Creek Water District (owner and operator). Review comments are considered before final publication of the Phase I Inspection Report. The written comments received are enclosed in Appendix E.

1.1.2 Purpose and Inspection

The findings and recommendations in this report were based on visual inspection of the project, minimal field survey measurements, and review of available design and operation data. The purpose of the inspection is to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures. Inspection procedures and criteria were those established by the Recommended Guidelines for Safety Inspection of Dams (Ref. 1).

The visual inspection of Newlan Creek Dam was made on June 26, 1980. HKM Associates personnel who attended the field inspection and contributed to this report were:

Dan Dyer, Geotechnical Engineer
Gary Elwell, Hydraulics/Hydrology
Mike Keene, Hydraulics/Hydrology, Team Leader

Other HKM personnel contributing to the report but not attending the field inspection were:

Dale R. Cunnington, Structural Engineer
William Hansen, Hydraulics/Hydrology
Dan Nebel, Geology

Other personnel present during the June 26, 1980 inspection included:

Glen McDonald, Supervisor, Montana DNRC, Dam Safety Section
Larry Tegg, Dam Safety Engineer, Montana DNRC, Dam Safety Section
Dave Jones, SCS
Glenn Malmquist, SCS
John Potter, Attorney for Newlan Creek Water District
Mike Bergum, Reservoir Manager
Ron Jackson, District Member

1.2 DESCRIPTION

1.2.1 General

Newlan Creek Dam is a compacted, earth fill dam located in the S1/2 of Section 11, T10N, R6E, M.P.M., Meagher County, Montana (Appendix A and Ref. 2 and 3). The Newlan Creek Water District owns and operates the project.

Newlan Creek Dam is a storage facility within the Missouri River Basin containing the water of Newlan Creek and tributaries. Released water is returned directly to Newlan Creek. Water then travels approximately 6.5 miles before joining the Smith River (Appendix A and Ref. 2). The nearest downstream community is Ulm, Montana, which is located near the confluence of the Smith and Missouri Rivers approximately 60 miles northwest of the dam. There are several residences located in the flood plain of Newlan Creek and the Smith River.

Newlan Creek Dam has a hydraulic height of 128 feet and impounds 15,600 acre feet (AF) at the first overtopping dam crest elevation (elevation 5282.4 feet NGVD). Based on a visual reconnaissance and engineering judgment, at least three residences, as well as county and private roads, private utilities, and agricultural land will be affected by a sudden

breach of the dam. On the basis of this information and in accordance with the Recommended Guidelines (Ref. 1), the project is classified as large in size and the downstream hazard potential is high (Category 1).

Newlan Creek Dam was constructed as a multipurpose storage project. The dam provides storage for irrigation and flood control, and provides a site of water-based recreation for local residents and tourists. Incidental benefits are provided for sediment accumulation. The dam has a 20-foot wide principal spillway, a 65-foot wide emergency spillway, and a 42-inch diameter outlet pipe. Storage to the normal pool level, or the principal spillway crest (elevation 5272.5 feet NGVD) is 12,230 acre-feet (AF) (Ref. 4 and Exhibit D1 of Appendix D). An additional 3370 AF are available for flood surcharge storage between the principal spillway crest and the first overtopping dam crest elevation (elevation 5282.4 feet NGVD).

Newlan Creek Dam has a total upstream contributory drainage area of 43.4 square miles. The Newlan Creek watershed is primarily characterized as forested hills and native range, pasture and hayland (Ref. 4). Elevations in the basin range from 7700 feet NGVD to about 5300 feet NGVD at the reservoir (Ref. 3). The reservoir is located in the foothills of the Little Belt Mountains (Photo 1 of Appendix B).

1.2.2 Regional Geology

Newlan Creek Dam is situated on the eastern edge of the Smith River Valley, a structurally complex region between the Big Belt uplift to the west, the Little Belt uplift immediately to the east and the Castle Mountain dome to the south and east. The dam is situated in a topography of high rounded shale hills. The strata dips steeply to the west (downstream) with the Spokane Shale Formation (pre-Cambrian) forming the surface in the abutment areas and the Flathead Quartzite (Cambrian) forming the surface in the toe area. Faulting is extensive in the area with major thrust faults extending the length of the Smith River valley east of White Sulphur Springs and numerous normal and reverse faults bordering the Little Belt uplift. There is, however, no evidence of recent fault movement (Ref. 5).

1.2.3 Seismicity

Newlan Creek Dam is in a moderately active to active seismic zone with the majority of the region's seismic events occurring in the southwestern Montana-Yellowstone Park area. Since 1925, Montana has experienced five shocks that reached intensity VIII or greater (Modified Mercalli Scale).

The closest epicenter of a shock of an intensity VIII or greater occurred in the Helena, Montana area which is approximately 50 miles west of the damsite. Numerous other shocks of intensity IV or greater have been reported within a 200-mile radius of the site (as of January, 1974). The site is located in Zone 3 of the Seismic Zone Map of Contiguous States, and it can be assumed that a major earthquake may occur within the life of the structure (Ref. 1, 6). Although the Zone Map is based on a known distribution of damaging earthquakes, it does not necessarily reflect accurate or adequate seismic design parameters for this site.

1.2.4 Site Geology

Numerous drill holes, test pits and site reconnaissance data for the dam are available. This section of the report is developed from this data, regional geologic information, and personal knowledge of the area.

The reservoir basin is composed of moderately metamorphosed siliceous argillites, arenaceous non-calcareous shale and quartzite sandstone of the pre-Cambrian Spokane Formation. The valley section consists of shallow alluvial deposits of silt, gravel, and clay from about 5 to 20 feet thick overlying argillite with lenses of quartzite and limestone.

1.2.5 Design and Construction History

Newlan Creek Dam was built in 1977 for the Newlan Creek Water District as a multipurpose storage project. Technical design assistance was provided by the Soil Conservation Service. Design material, plans, specifications, testing records, construction diaries, and associated information are available in the Bozeman, Montana, SCS office. General construction contractor on the original structure was Rehbein Construction Company, Plains, Montana. The concrete work was subcontracted to COP Construction of Billings, Montana. The total irrigation project was never completed because the SCS decided during construction that diversion of water from Sheep Creek into Newlan Creek above the dam and construction of irrigation canals below the dam were not environmentally or economically feasible.

Before and during design many investigations and tests were performed. About 66 exploration borings and greater than 200 test pits were made during the geologic investigation. Extensive laboratory tests were performed on selected borrow area and test hole samples. These tests included: moisture-density relationships, grain-size distribution, Atterberg limits, laboratory permeability, triaxial shear, direct shear, unconfined compression, total dissolved solids, absorption, and slaking

tests. Embankment slope stability was evaluated by computer during design using the "ordinary method of slices". The effects of seismic loading were estimated and soil strength parameters were determined from laboratory test results. For a more complete discussion of the investigations, tests, and results see Section 2.3.3.

Inspection and quality control testing were performed during construction. Based on a review of the records, it appears that the dam was constructed generally in accordance with construction specifications. Letters in the design file (Ref. 4) note that quantities of material used during construction varied slightly from those anticipated in design. Also, the configurations of Zones II and III were changed during construction to accommodate an error during fill placement. For complete details see Section 2.3.1. Changes in the configuration of Zones II and III were considered in stability calculations during construction (see Section 2.3.3).

Several significant repairs have been made to Newlan Creek Dam since 1977. The repairs came in 1978 when modifications were made to the outlet works. Repairs included cradling the irrigation outlet steel pipe manifold in concrete, adding a joint block to the 42-inch concrete pipe/steel pipe adapter coupler and flexible coupler, and installing additional drainage. A corrugated metal access riser was installed over the pressure manhole that was installed during the original construction (Correspondence, Appendix E). Williams Brothers Construction of Lewistown, Montana, performed the repair work.

Principal spillway repairs were required in 1979. Differential settlement occurred in the spillway causing the spillway chute to buckle. Repairs included replacing and modifying sections of the spillway chute and providing thickened joint material to allow for additional settlement and compression. Steel Structures, Billings, Montana, performed the repairs.

CHAPTER 2
INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

2.1.1 Spillway

Newlan Creek Dam has two spillways. A principal spillway is located on the dam face. An emergency spillway is positioned on the left (south) abutment.

2.1.1.1 Principal Spillway

The principal spillway is located approximately 500 feet from the left (south) abutment. The principal spillway consists of a log boom, a low stage box inlet, a high stage box inlet, a 30-inch diameter joint pool drawdown structure, a 20-foot wide concrete chute, and a stilling basin with baffle blocks. The chute is crossed by a 30-foot wide, clear span bridge deck (Sheets 1, 9-14 of Exhibit C1 and Photos 2-5 of Exhibit B).

The principal spillway inlet is protected by a log boom. The logs have a minimum diameter of 9 inches, and lengths of 16, 20 and 24 feet. The logs are interconnected with 5/8-inch diameter 6 x 19 wire rope and attached to concrete anchor blocks at the ends (Sheet 14 of Exhibit C1 and Photo 2 of Exhibit B).

The low stage box inlet has a crest elevation of 5272.5 feet NGVD. The box inlet is constructed of reinforced concrete. The box is 4 feet wide and 12 feet long. There is a 2.5-foot high and 4-foot wide orifice located in the high stage box. The invert of the box inlet and orifice is 5264.5 feet NGVD. Two 6-inch diameter perforated asbestos cement (AC) drain pipes drain into the box. All drain outlets are designed with small animal guards (Sheets 9 and 11 of Exhibit C1 and Photo 4 of Appendix B).

The high stage box inlet crest elevation is 5275.5 feet NGVD (based on box inlet invert elevation 5264.5 feet NGVD). Reinforced concrete construction is used. The box inlet is 20 feet wide and 32.5 feet long. From the upstream direction, the sidewalls have a horizontal crest for 17.5 feet and a slanted crest (1 vertical on 2.5 horizontal) for the next 15 feet. The invert of the box inlet is 5264.5 feet NGVD. Two 6-inch diameter perforated AC drain pipes parallel the box sidewalls and drain into the inlet at 4 locations. Small animal guards are designed to cover all the drain outlets (Sheets 9 and 11 of Exhibit C1 and Photo 4 of Appendix B).

The joint pool drawdown structure is located on the right (north) side of the box inlets. This structure is to be used for making small reservoir releases at high pool levels. A 30-inch diameter, 29-foot long welded steel pipe is the conveyance feature between the pool and chute spillway. The pipe is near vertical at the inlet and has an inlet elevation of 5266.5 feet NGVD. Control is provided by a manually operated 30-inch diameter slidegate valve at the inlet. The pipe inlet is protected by a trashrack constructed of 1.5-inch diameter galvanized steel pipe and 3-inch by 5/8-inch barstock. The inlet is parallel to the principal spillway. Downstream of the pipe inlet, the pipe makes two 45 degree bends and enters the high stage box (Sheets 9, 11 and 13 of Exhibits C1 and Photo 4 of Appendix B).

A 20-foot wide reinforced concrete chute is located downstream of the boxes. The first 30 feet of the chute is covered by a clear span, reinforced concrete bridge deck. The chute has an invert elevation of 5264.5 feet NGVD, and the bottom of the bridge deck is 16 feet above the invert. At a point 15 feet downstream of the bridge, the chute begins a transition from horizontal to an incline which follows the downstream face of the dam. Near the top and bottom of the chute there are several drain outlets (Sheets 1, 9, 11 and 12 of Exhibit C1 and Photo 5 of Appendix B).

Energy dissipation is provided by a concrete stilling basin. Concrete baffle blocks are located on the stilling basin floor. The stilling basin is approximately 48 feet long. The sidewalls reach a maximum height of 23 feet adjacent to the baffle blocks. Downstream of the baffle blocks the sidewalls are flared and taper down to ground level. The invert downstream of the blocks is composed of a layer of rock riprap about 2 feet thick (Sheet 12 of Exhibit C1). The principal spillway stilling basin is also used by the irrigation outlet. See Section 2.1.2 for a description of the irrigation outlet.

A Parshall flume is located about 300 feet downstream of the concrete stilling basin. A 72-inch culvert is located under the gravel access road about 350 feet downstream of the concrete stilling basin. The SCS determined the downstream channel capacity to be 190 cubic feet per second (cfs) and a 72 by 44 inch arch pipe was chosen to pass this flow. This discharge also corresponds with the capacity of the low stage box inlet with the reservoir pool elevation at the crest of the high stage box inlet and having the joint pool drawdown structure closed.

The log boom appears functional and in good shape. There is 6 to 9 inches of debris in the bottom of the low stage box inlet. Concrete on the low stage box inlet appears in good condition

except for minor cracking on the south side. There is some chipping on the south side of the high stage box inlet that might have occcurred during rock riprap placement. There is also cracking on the south side of the box and where the concrete wall joins the bridge on the upstream side (Photo 8 of Appendix B). The recently placed joint filler material varies in thickness from 1-1/2 to 4 inches along the spillway chute. Many of the small animal guards on the drain outlets are damaged or absent. The bank protection downstream of the concrete stilling basin appears to be in excellent condition, with the exception of a small amount of riprap slippage along the right (north) wing wall. The channel between the stilling basin and Parshall Flume is also in good condition. The banks appear stable and have an adequate vegetative cover. Movement is evident in the stilling basin wingwalls (Photo 9 of Appendix B). For a complete discussion of the movement see Section 2.3.2.

Hydraulic rating data for the principal spillway was available in the SCS design files (Ref. 4). The calculations were numerous, appeared incomplete, and could not be easily verified. Therefore, new spillway rating information was developed using the weir head-discharge equation and the orifice equation. Principal spillway capacity to the first dam crest overtopping elevation (5282.4 feet NGVD) is 3870 cfs. Final spillway rating data is summarized in Exhibits D2 and D3 of Appendix D. The chute and stilling basin appear to have capability for passing 3870 cfs.

2.1.1.2 Emergency Spillway

A rock emergency spillway is constructed in argillite material on the left (south) abutment. It was designed as a broad-crested spillway. The approach section invert is at approximately elevation 5270.0 feet NGVD for 150 feet and then rises at a slope of 0.2 foot/foot for 40 feet. The control section is 65 feet wide, 100 feet long and has an elevation of 5278.3 feet NGVD. The spillway invert then slopes downward at 0.05 foot/foot for a distance of 160 feet. The spillway grade flattens to a slope of 0.01 foot/foot for about 210 feet before reaching the natural terrain. Sideslopes throughout the spillway are 1V on 2H. An access road passes through the emergency spillway near the downstream end of the cut section (Sheets 1 and 5 of Exhibit C1 and Photo 6 of Appendix B).

The emergency spillway appears to be in generally good condition. There is some soil sloughing occurring on the terraced hillside (southside). The small benches of the terrace are generally intercepting and collecting the sloughed material, and hence, the spillway channel is not presently being affected (Sheets 1 and 5 of Exhibit C1, Exhibit C3 and Photo 7 of Appendix B).

Adequate emergency spillway rating information is not available in the SCS design files (Ref. 4). Therefore, a new spillway hydraulic rating was developed. Critical depth was assumed to occur at the downstream end of the 100-foot long control section. A Mannings "n" of 0.04 was assumed and approach losses were considered. Emergency spillway capacity to the first dam crest overtopping elevation (5282.4 feet NGVD) is 1390 cfs.

2.1.2 Outlet Works

The outlet works is located approximately 200 feet from the left (south) dam abutment. It consists of a 24-inch low stage drain, an inlet riser, a 42-inch irrigation outlet pipe, a pipe junction assembly and an outlet structure (Sheets 1, 6, 7 and 8 of Exhibit C1 and Photos 5 and 10 of Appendix B).

The low stage drain is a 24-inch diameter, coal tar enamel coated, steel pipe. The pipe is about 140 feet long. There is an inlet channel, but no inlet structure. This section of pipe is horizontal and enters the inlet riser near the upstream toe of the dam (Sheets 6 and 7 of Exhibit C1).

The inlet riser is constructed of reinforced concrete and has an inside length and width of 5.5 feet. The riser has a crest elevation of about 5207.0 feet NGVD and an improved (chamfered) inlet. The riser contains a hydraulically operated 42-inch diameter slidegate which functions as an emergency gate on the 42-inch irrigation outlet pipe which connects to the bottom of the riser (Sheets 6 and 7 of Exhibit C1 and Photo 2 of Appendix B). The hydraulic controls are located in a control cylinder on the dam crest.

The inlet riser and pipe junction assembly are connected by 526 feet of 42-inch diameter reinforced concrete pipe (RCP). The pipe rests on a concrete cradle in contact with argillite bedrock. A portion of the pipe, as shown on Sheet 6, Exhibit C1, rests on a reinforced concrete cradle in contact with core trench fill. Anti-seep collars are placed throughout the impervious zone. The pipe joints are sealed with round rubber gaskets and joint sealing compound.

The pipe junction assembly, near the downstream toe of the dam, allows separation of flow into the separate outlet systems. At the present time, two of the outlet systems are valved closed and have blind flanges installed on the pipe stubs downstream of the valve box. The assembly also includes a 42-inch diameter steel pipe with pressure manhole, a steel reducer, a 24-inch steel pipe with gate valve, a 6-inch diameter steel pipe bypass with 4-inch

diameter gate valve, a 42-inch diameter steel pipe with pressure manhole, a steel pipe eccentric reducer, and a 24-inch steel pipe which daylights in the principal spillway stilling basin. A 3-inch air vacuum valve is located just downstream of the 24-inch gate valve. The valve assemblies are all located in a concrete valve control box. Since the valve control box is located near the downstream toe of the dam, the conduit through the dam is pressurized and subject to the full head of the reservoir. For details of the outlet systems see the construction plans (Sheets 6, 7 and 8 of Exhibit C1 and Photo 10 of Appendix B).

The outlet structure for the operable 24-inch steel pipe is the principal spillway stilling basin. For a discussion of the stilling basin see Section 2.1.1.1.

Due to the inaccessibility of the pressurized 42-inch conduit, inspection of the outlet works was limited to operating the gates and a cursory inspection of the valves.

The outlet works valves were all operated. The hydraulically operated guardian gate in the inlet riser could not be closed completely. The SCS did not want to attempt a full closure because pressure was building up in the hydraulic lines and the hydraulic fluid might escape through a suspected leak in the line. They suspect a rock might be lodged in the gate frame. The two gate valves on the nonoperational portion (the middle and south valves) of the outlet works appear to seat very well. The middle valve was opened about 4 inches. The valve operated without binding, but was not opened further due to the blind flange on the end of the pipe and no place to discharge the water. After closure, the packing was checked and found to be dry. It is assumed the valve could be operated throughout the full travel distance without difficulty. The south valve was also operated about 4 inches and was found to be in equally good condition as the middle valve with the exception of a slight amount of seepage in the packing material. The 4-inch gate valve and 24-inch gate (north) valve on the operational portion of the outlet works were closed to test their seating capability and measure the quantity of seepage passing under and/or around the dam. It was possible to obtain nearly complete seating, but about 3 cfs was measured at the Parshall flume. A portion of the 3 cfs was the result of seepage under and around the dam and based on sounds it was felt a portion was leakage occurring in the 4-inch gate valve. The 24-inch gate valve was opened to nearly a fully open position and a flow of 21 cfs was measured at the flume. It was concluded that between 18 and 21 cfs was passing under the guardian gate at the inlet riser, with the gate closed as much as possible. The north gate valve operated satisfactorily throughout the full range of travel, although

the packing material was seeping. A plastic filler material had been placed around the valve to reduce leakage, but a small amount of leakage was still present. Evidently complete repair has not been possible due to inability to completely close the guardian gate. Subsequent to our investigation, the SCS indicated that the guardian gate hydraulic system is completely inoperable, and the valve has been blocked and chained open to allow passage of water through the outlet works.

Outlet works hydraulic rating information was available from the SCS design files and was satisfactorily verified assuming orifice flow at the 24-inch diameter operating valve (Ref. 4). Outlet works capacity is 103 cfs and 108 cfs to the principal spillway crest elevation (5272.5 ft NGVD) and the first dam crest overtopping elevation (5282.4 ft NGVD), respectively.

2.1.3 Freeboard

The guidelines' (Ref. 1) recommended spillway design flood (SDF) for a large, high hazard dam is the full PMF. Flood routing (Section 2.2.3) indicates the dam overtops during the SDF, and therefore, no freeboard exists for such conditions. The vertical distance from the principal spillway crest (elevation 5272.5 feet NGVD) to the first overtopping dam crest elevation (5282.4 feet NGVD) is 9.9 feet. The vertical distance between the reservoir pool and the first overtopping elevation at the time of the June 1980 field inspection was 18.0 feet.

Newlan Creek Reservoir is basically oriented in a northeast-southwest direction, with the dam on the southwest side. The prevailing wind for this region is generally identified as being westerly (Ref. 7, 8). The reservoir location and orientation can be observed in Appendix A. The effective fetch length for wind generated waves is calculated to be 2 miles. Hence, a minimum vertical distance from the maximum water surface during the spillway design flood and the dam crest should be 5 feet (Ref. 9). Even though the dam will be overtopped during the SDF and lesser floods, the vertical distance between the normal reservoir and top of dam is adequate to prevent overtopping by wind generated waves.

2.2 HYDROLOGY

2.2.1 Physiography and Climatology

The 43.4 square mile catchment area above Newlan Creek Dam is irregular in shape, with the length dimension being considerably greater than width (Appendix A). In particular, the drainage area is approximately 10 miles long and 4 miles wide and is characterized by the following breakdown: 49.5 percent National

Forest, 6.5 percent private forest, and 44.0 percent native range, pasture and hayland. Less than one percent of the area falls in a miscellaneous land use category. The immediate vicinity of the reservoir can primarily be characterized as foothill drainage. The ground cover conditions throughout the basin are rated fair to good (Ref. 4). The watershed rises from the reservoir northeasterly to the Little Belt Mountains. Soils in the lower portion of the drainage area are primarily Castner Stony Loam and Delpine Shaly Loam with mountain timbered soils in the upper elevations (Ref. 10).

The regional climate is classified as distinctly continental, and characaterized by abundant sunshine, low relative humidity, moderate rainfall, and wide daily and seasonal variations in temperature. However, the regional climate does not have the extreme variable pattern common to the more mountainous western sections in Montana. In general, the valleys are relatively dry during the colder months and wet during the late spring and early summer. The wettest part of the year in the mountains is generally from midwinter to early spring. It is not uncommon for the region to experience winter warming spells with associated thawing temperatures. Precipitation near the Newlan Creek watershed ranges from about 17.5 inches at White Sulphur Springs (6 miles south of the dam) to amounts in excess of 30 inches in the Little Belt Mountains. The average annual temperature at White Sulphur Springs is approximately 41 degrees Fahrenheit. Winters are typically cold, with January being the coldest month. The monthly average temperature for January at White Sulphur Springs is about 20 degrees Fahrenheit. During the summer, July is typically the warmest month with an average temperature of about 64 degrees Fahrenheit (Ref. 7, 8).

Streamflow measurements are taken at the Parshall flumes both upstream and downstream of the dam. Reservoir pool elevations are taken from staff gages on the upstream face of the dam. Pool elevations are recorded 3 or 4 times a week in the summer and 3 or 4 times a month in the winter. Pool elevation records are reported to be available in the Newlan Creek Water District office.

2.2.2 Estimated Probable Maximum Flood (PMF)

The probable maximum precipitation (PMP) and the estimated probable maximum flood were developed for the Newlan Creek drainage basin. The ratio of the reservoir area to the nonreservoir area is less than 1 percent; therefore, the two areas were not separated for the purpose of this analysis.

The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the study region.

Newlan Creek is located west of the 105th meridian and east of the continental divide, hence PMP values were calculated using procedures associated with the National Weather Service's Interim Method (Ref. 11). The Interim Method provides PMP values for durations of 6 to 72 hours, with PMP values for 1 to 5 hours obtained by multiplying the 6-hour PMP value by percentages supplied by the Corps of Engineers, Seattle District. The PMP 6-hour, 12-hour, 24-hour, 48-hour, and 72-hour values are 9.8 inches, 12.0 inches, 14.6 inches, 17.0 inches and 18.6 inches, respectively. The 6-hour PMP value of 9.8 inches was multiplied by 67 percent, 78 percent, 85 percent, 91 percent, and 95 percent to obtain PMP values of 6.6 inches, 7.6 inches, 8.3 inches, 8.9 inches and 9.3 inches for durations of 1-hour, 2-hours, 3-hours, 4-hours, and 5-hours, respectively.

The 6-hour increments for the total 72-hour storm were arranged in a critical distribution using criteria presented in the National Weather Service's Hydrometeorological Report No. 43 (Ref. 12). In particular, the 6-hour rainfall increments were arranged according to pattern "e". Further subdivision of the calculated rainfall increments was required to provide compatibility with the duration of the unit hydrograph. A 15-minute unit hydrograph was chosen for Newlan Creek Dam using criteria presented in the SCS Hydrology Handbook (Ref. 13). The unit hydrograph was developed for the Newlan Creek basin using the SCS method and the U.S. Army Corps of Engineers' computer program HEC-1 (Ref. 13, 14). The PMP storm was plotted in the form of a depth-duration curve for convenience in selecting incremental rainfall values. The peak 15-minute PMP values, within the time base of the unit hydrograph, were ordered according to the reverse pattern of the unit hydrograph ordinates.

Rainfall losses were assumed equal to the minimum soil retention rate of 0.15 inches/hour for type B soils (soils having a moderate infiltration rate) due to an assumed saturated ground condition. It is felt that the saturated soil will still continue to pass a minimum quantity of water.

The runoff condition, or PMF, resulting from a PMP storm was estimated using the PMP values and the unit hydrograph approach. The resultant PMF has a peak flow of 100,900 cfs and a 72-hour volume of 25,500 AF.

2.2.3 Flood Routing

The PMF resulting from the PMP rainfall/runoff event was routed through Newlan Creek Reservoir using the computer program HEC-1 (Ref. 14). Runoff from an antecedent storm was not specifically considered; however, it appears reasonable to assume the initial reservoir level prior to routing the PMF is at the principal

spillway crest (elevation 5272.5 feet NGVD). The support rationale for this assumption is that Newlan Creek Dam is not capable of totally absorbing rather severe flood events. Drawdown of the reservoir pool can be accomplished with the 42-inch outlet conduit. However, it is not likely that the project would be operated in this manner unless it was an emergency measure. The water users would prefer to store as much water as possible in preparation for the irrigation season. It may be possible for the reservoir to be at the emergency spillway level at the beginning of the PMF due to an antecedent flood. This condition was not studied during this analysis since the project can only handle a relatively small percentage of the SDF when routing begins with the reservoir at the principal spillway crest.

Reservoir elevation-area-capacity data was available from SCS design files (Ref. 4) and is provided in Exhibit D1 of Appendix D. Newlan Creek Dam discharge rating data was available in the SCS design files (Ref. 4), but only the outlet works results could be verified. New rating data was developed for the principal and emergency spillways using the weir head-discharge equation and the orifice equation. Hydraulic rating data is shown in Exhibits D2 and D3 of Appendix D. Flow through the outlet works was not included in the flood routing because flow through the gate would probably be insignificant during a typical late spring, early summer flood event.

For the purposes of flood routing and according to Phase I inspection criteria, the dam crest elevation is the minimum elevation to which the reservoir must rise before overtopping the dam. This criteria assumes overtopping and failure of embankment-type dams to be coincidental. Based upon the dam crest profile survey dated June 26, 1980 (Exhibit C2 of Appendix C), the existing low-point dam crest elevation is 5282.4 feet NGVD.

Flood routing showed that the dam would first overtop during the PMF when approximately 18 percent of the total PMF volume enters the reservoir. Routings were made of lesser hypothetical floods than the PMF to determine the magnitude of floods the dam can contain. The hypothetical hydrographs are obtained by applying percentages to the PMF ordinates. A flood with a hydrograph having ordinates corresponding to 18 percent of the PMF ordinates is just controlled by the project. Larger floods would overtop the dam.

2.3 GEOTECHNICAL EVALUATION

The geotechnical evaluation of Newlan Creek Dam included a field investigation and a search and review of project data. The field

inspection consisted of photo documentation, a dam crest profile survey, slope stability observations of the dam embankment, piezometric water level measurements, and measurements of the slope angles. Inspection photos are included in Appendix B. Some of the construction plans are included in Exhibit C1 of Appendix C, and the crest profile survey is shown in Exhibit C2. Results of the piezometric water level and slope angle measurements are provided in Exhibits C3 and C4.

A search and review of the project data revealed that considerable information is available in the design file (Ref 4). The information includes: a geology report, which describes the method and scope of the subsurface exploration program; extensive laboratory test results; a detailed description of the subsurface findings at the damsite; the Preliminary Design Report with embankment design calculations, including slope stability; a summary of field density determinations; and as-built construction drawings.

2.3.1 Dam Embankment

Newlan Creek Dam is a compacted, zoned, earth fill structure which was completed in July 1977. The dam has an estimated maximum structural height above the deepest point in the principal spillway stilling basin of 137 feet and a total crest length of 850 feet. Included in the embankment section is a 20-foot-wide concrete spillway (Photo 3 of Appendix B). The dam crest was designed with a width of 30 feet. Field measurements approximately verify the crest width (Photos 3 and 7 of Appendix B).

The construction plans (See Sheet 3 of Exhibit C1) indicate the upstream face of the main dam has a slope of 1V on 2-1/2H down to elevation 5273 feet, then 1V on 3H down to elevation 5255 feet (Photo 11 of Appendix B), then 1V on 3-1/2H down to the toe. Slope measurements in the field verify the 1V on 2-1/2H slope. There are four 10 to 20-foot-wide horizontal berms on the slope. The upstream face was designed with 24-inch cover of loose, rock riprap on the face with a 12-inch riprap bedding blanket (Photo 2 of Appendix B). A description of the riprap and its present condition is discussed in Section 2.3.4. Debris on the upstream face is limited to very small material. There are light scattered weeds growing in the rock riprap area on the upstream face.

The downstream face of the dam has a uniform slope of 1V on 2H with three 10-foot-wide berms. This slope was approximately verified in the field. The face is void of vegetation and has some minor erosional scars which are discussed in Section 2.3.3 (Photos 3, 5 and 7 of Appendix B).

Details provided on Sheet 3, Exhibit C1 indicate the embankment cross section consists of four zones plus the riprap section. A brief description of these zones is given in the design report (Ref. 4) as follows:

> "Zone I is the core zone of the dam and weakest material to be used. This soil will be CL-1, CL-2, CH's and some MH material. The source of this material is borrow area C, approximately 323,500 cubic yards will be required.
>
> Zone II will lie adjacent to Zone I, both upstream and downstream. This material will be SC and SM (exhibiting some plasticity). This material can contain gravels and will generally have 25 to 60% fines. (The portion of the soil mass passing the three (3) inch sieve opening shall contain not less than twenty-five (25) percent nor more than sixty (60) percent fines.) This material should have a very low permeability rate. Primary source of these materials is borrow Area A, but additional material should be available from the foundation excavation and borrow areas B and C. Approximately 296,000 cubic yards will be required.
>
> Zone III will lie just downstream from Zone II, the material will be somewhat coarser than Zone II. They will classify as GC, GM and GW. In general, they will contain from 10 to 50% plastic fines. If sufficient quantities of this material are available the boundary between Zone II and III may be steepened. Zone II materials are available in borrow Area C. Approximately 45,000 cubic yards will be required.
>
> Zones IV and V are rock zones. Zone IV is argillite, a metamorphic shale material. Zone V will consist of quartzite talus rocks. The argillite will weather on the surface of the slope, but even the weathered rock maintains a slatey cleavage. The quartzite is a much more durable material and will be placed below the elevation of intermittent saturation. The emergency spillway excavation will be the primary source of Zone IV materials. Surface rocks on both abutments originating from higher talus slopes will be the source of Zone V materials and rock riprap. Approximately 263,000 cubic yards of Zones IV and V material will be required."

It is noted from letters in the design file (Ref. 4) that the quantities of material used during construction varied slightly from those anticipated in design. In addition, the configurations of Zones II and III were changed during construction to accommodate an error during fill placement. This change is shown on Sheet 3 of Exhibit C1.

The core trench is filled with Zone I material and is located at the base of the impervious section on the upstream side of the dam embankment. The drawings also indicate the core trench is up to about 30 feet deep and extends into the underlying bedrock (Sheet 2 of Exhibit C1). Post-construction correspondence in the design file (Ref 4) supports the fact that the core trench penetrates through the upper fractured bedrock to competent material.

There is a 65-foot-wide emergency spillway cut into bedrock around the left abutment. The left permanent cut slope of the emergency spillway is approximately 135 feet high. This cut is designed with a slope of 1V on 3/4H intersected at 20-foot vertical intervals with seven berms from 10 to 15-feet-wide. The exposed material in the excavation is argillite bedrock (Photo 7 of Appendix B).

Sometime after completion of the dam embankment, seepage began exiting on the downstream face near the left abutment. Twelve piezometer tubes were installed in a grid pattern along the berms to monitor the seepage and determine its origin. It was discovered that there was a leak in the irrigation outlet manifold and it was saturating the embankment soils. A discussion of the outlet works repair was presented previously. After repairing the outlet, the water levels dropped in the piezometer tubes and the seepage on the downstream face stopped.

Locations of these tubes are shown on Exhibit C3 of Appendix C. Measurements of water levels are summarized in Exhibit C4 of Appendix C. A history of piezometric water level measurements is available at the Soil Conservation Service office, White Sulphur Springs, Montana.

A gravel road was constructed across the top of the dam (Photo 3 of Appendix B). The road section consists of about 1 foot of Zone IV material. The road is apparently graded frequently by Meagher County road equipment, and is presently in good condition.

Inspection and quality control testing were performed during construction. Compaction test results are available in the design file (Ref. 4). A review of these records indicates the dam was constructed generally in accordance with the construction specifications.

2.3.2 Foundation Conditions and Seepage Control

Approximately 66 exploration borings and more than 200 test pits were made during the geologic investigation of Newlan Creek Dam. Abridged logs of the 91 test pits are included in the construction drawings in the design file (Ref. 4).

Extensive laboratory tests were performed by the Portland Material Testing Section and the Lincoln Soils Mechanics Laboratory of the Soil Conservation Service on selected samples taken from the borrow areas and test holes. These tests included: moisture-density relationships, grain-size distribution, Atterberg limits, laboratory permeability, triaxial shear, direct shear, unconfined compression, total dissolved solids, absorption, and slaking tests. The results of these tests are available in the design file (Ref. 4).

All alluvial materials under the entire base of the dam were removed at the time of construction (see SCS comment, Appendix E). The embankment is resting on stratified silty argillite and fine-grained quartzite bedrock. The argillite is partly metamorphosed sedimentary rock which is slightly susceptible to degradation due to handling and exposure to the weathering elements (Sheet 2 of Exhibit C1). The core trench described earlier extends through these materials into the foundation bedrock (see Sheet 2 of Exhibit C1).

Settlement

The construction plans indicate that the dam crest control was established at elevation 5282 feet NGVD (Sheet 3 of Exhibit C1). An embankment profile was surveyed during the field investigation (Exhibit C2 of Appendix C). The survey shows that the maximum differential elevation along the the main dam crest is about 0.3 foot. The crest (road) is graded regularly by Meagher County maintenance equipment, hence the differential elevation is not a good measure of total settlement. The dam was designed with about 1%, or 12 inches, of camber.

According to information available in the design file (Ref. 4) significant settlements were identified at the chute spillway inlet and at lower concrete chute sections in 1978. Sufficient differential settlement had occurred, due to the zoned embankment cross section, to cause some rotation of the concrete sections. The result of this movement was spalling and cracking of the concrete chute, separation of the chute from its foundation, shearing of some asbestos cement drains, and compression and extrusion of joint filler in the concrete chute. It was concluded by the SCS that the settlement within the dam resulted in a shortening of the spillway and vertical displacement and rotation of the spillway inlet.

Repairs on the chute were made in 1979 including replacement of the drain pipe behind the chute walls. A record of settlements since the repairs is available in the SCS office, Bozeman, Montana. SCS information in the design file documents that additional settlements have occured but at a decreased rate and

magnitude. During this national dam safety investigation, it was noted that the drain pipe behind the chute walls is again slightly displaced.

Some movements have occurred at the stilling basin wing walls. At the right wing wall, a slight rotation in the same plane as the wall has resulted in up to a 1-inch separation at the stilling basin wall and the wing wall (Photo 9 of Appendix B). Also, this wing wall has moved in a perpendicular direction toward the basin approximately 1-1/2 inches.

The left wing wall (south side) has moved in a perpendicular direction toward the basin approximately 3 inches. Presently, neither of these wing walls is considered a safety hazard. The wing walls are designed and constructed to allow rotation and tilting independent of the basin. This is to allow the backfill to assume an active loading condition and to prevent moment transfer at the wing wall/basin joint. Thus, the wing walls are essentially an independent cantilever retaining wall whose movements are not unexpected nor unreasonable. The wing wall/basin joint contains a PVC waterstop. The footings for both wing walls are resting on bedrock, thus, settlement is not expected to contribute to the movements (see SCS comments, Appendix E).

There is some movement in the backfill relative to the chute, on the right (north) side of the chute, near the control section, at the drain pipe exit, where a displacement of about 1/2 inch is evident.

Seepage Control

Under-the-dam seepage is controlled by essentially two drain systems installed at the base of the embankment (Sheet 4 of Exhibit C1). The plans indicate that the original drain consists of extensive gravel blankets on each of the abutments downstream from the dam centerline. Water is collected by a 6-inch perforated asbestos-cement pipe and conveyed to the downstream toe. This water is collected from the abutment areas with a 6-inch non-perforated asbestos-cement pipe. In addition, spring water, which surfaces near the center of the embankment, is collected and carried to the non-perforated asbestos-cement pipe. Water from these three areas is carried in the 6-inch non-perforated asphalt-pipe which runs parallel with the axis of the dam. A "T" section takes off near the concrete chute section and exits in the chute spillway stilling basin.

A second drain system was installed to dewater the embankment which was saturated due to the leak in the irrigation outlet manifold (Sheet 4 of Exhibit C1). A large gravel blanket was

placed at bedrock contact around the areas where the outlet manifold was repaired and cradled with concrete. Water is collected in an 8-inch perforated polyvinyl chloride (PVC) pipe which runs along the toe of the embankment and exits into the stilling basin. This pipe is perforated along the entire length. The volume of seepage exiting from this pipe was estimated during this field inspection to be between 15 and 20 gallons per minute. This system appears to be functioning properly. All drain pipe, perforated and nonperforated, is enveloped in drain fill designed to transmit a water flow equal to that of the pipe (see SCS comments, Appendix E).

At the time of the June 1980 field investigation, Newlan Creek Reservoir was at elevation 5264.5 feet. No major seepage areas were identified during this investigation. Small spring areas are apparent near the natural stream channel several hundred feet below the dam. In conclusion, under-the-dam seepage appears to be insignificant to the safety of the structure at this time.

An analysis of the piezometric water elevations summarized in Exhibits C3 and C4 of Appendix C, suggests that the phreatic surface is close to the embankment surface near the downstream toe. However, seepage is not surfacing, but rather, is apparently being picked up by the drain system. The high phreatic surface near the toe does not presently create a dam safety problem. Periodic monitoring of these water levels for changing conditions will better define the phreatic surface and stability conditions.

2.3.3 Stability

General

The slope angles measured during the field investigation are shown in Exhibit C3 of Appendix C. These angles were measured with an Abney level and should be considered approximate.

Some anticipated slope stability problems exist in the natural permanent cut slopes of the emergency spillway (Photo 7), and the cut above the irrigation pipe outlets (Photo 10). There is no outward sign of instability in the embankment.

Cut Slopes

The permanent 135 foot high cut slope on the left side of the emergency spillway has several small slope failures (pop-outs) (Photo 7 of Appendix B). The construction plans (Sheet 5 of Exhibit C1) indicate this cut was designed with 10 to 15 foot wide berms placed at 20 foot vertical intervals. Due to slides with up to 3 foot deep scarps, and to pop-out spoils on berms

from slides above the berm, the effective berm width is reduced to as little as 2 feet in places.

In general, the lower part of the emergency spillway cut slope appears to be in slightly better condition than the upper part because the bedrock, exposed near the toe of the cut, is a deeper structure in the formation and is more durable than the upper materials. Pop-outs occur where the argillite bedrock is degradated by exposure to the elements while the deeper bedrock remains competent. Periodic maintenance will be required to keep the spillway clear of talus from the cut slope. Although the pop-outs disfigure the emergency spillway construction, the general slope stability appears adequate.

At the irrigation outlet, the natural subsoils have been excavated to an estimated vertical height of between 15 to 20 feet on the left (south) side of the channel (Photo 10 of Appendix B). Field measurements indicate this slope varies from 41 to 52 degrees. Some material has sloughed off of this cut and is deposited in the partially completed irrigation channel below. The slope is composed of some clay and gravel near the surface, but it is predominantly weathered argillite. Because of the steepness of the cut and the soil characteristics, it is likely that the material will continue to slough. Although this slope is unstable, it does not create a safety hazard to the facility as construction of the irrigation system is not complete and the outlet is not operable (see SCS comments, Appendix E). The sloughing material is slowly covering the pipe stubs and blind flanges of the irrigation outlet, which is creating a future inconvenience and will limit inspection access.

The slopes of the outlet channel downstream from the embankment and upstream of the Parshall flume are stable and in good condition.

Embankment

The embankment slope stability was evaluated during design by computer using the "ordinary method of slices". The effects of seismic loading were estimated using a coefficient of horizontal acceleration of 0.1g. Soil strength parameters were determined from laboratory test results. A summary of the soil properties used in the original design are presented in Exhibit C5 of Appendix C. The following minimum safety factors (F.S.) were required by the SCS design standards:

Upstream Face

F.S.	1.0 (full drawdown with seismic)
F.S.	1.25 (drawdown)

Downstream Face

F.S. 1.10 (steady seepage with seismic)
F.S. 1.30 (steady seepage)

The following minimum factors of factors of safety (F.S.) were summarized in the calculations:

Upstream Face

F.S. 1.03 (full drawdown with seismic)
F.S. 1.41 (drawdown)

Downstream Face

F.S. 1.11 (steady seepage with seismic)
F.S. 1.39 (steady seepage)

The location of the phreatic surface used for the downstream face stability calculations is approximated on Exhibit C4.

In addition, the changes in the configuration of Zones II and III were considered in stability calculations during construction. The results were compatible with the original minimum requirements.

In summary, no outward embankment stability problems are evident. The calculated factors of safety for Newlan Creek Dam meet the Recommended Guidelines for Safety Inspection of Dams (Ref. 1) except for the steady state seepage condition where F.S. = 1.39, which is less than the recommended F.S. = 1.50. However, it should be noted that the measured phreatic surface in the embankment is higher than that anticipated in the original design calculations (See Exhibit C4).

Concrete Structure Stability

Movements in the wing walls of the chute spillway stilling basin have been discussed previously (Photo 9 of Appendix B).

The foundation and backfill of the chute spillway are stable and in good condition. However, some movement in the backfill relative to the chute is apparent due to the drain pipe exit displacement as discussed previously.

Erosion

Several erosional channels have been cut in the downstream face of the embankment and in the emergency spillway cut slope (south wall) by surface runoff waters (Photo 7 of Appendix B). This

erosion is not currently affecting dam stability but may eventually disfigure the structure if not corrected.

The reservoir shorelines are considered to be in stable condition as no major slides or scarpments were observed. The shoreline is occasionally vertical, or near vertical, to heights of less than 2 feet and localized sloughing occurs due to wave action and saturated conditions.

2.3.4 Rock Riprap

Rock riprap has been placed on the upstream face of the dam (Photos 2 and 11 of Appendix B), and in the stilling basin for the chute spillway and low level outlet works (Photo 9 of Appendix B). This rock is quartzite sandstone and is generally erosion resistant. The riprap is adequate and in excellent condition.

At one location in the chute spillway stilling basin, the riprap has slipped downslope slightly (Photo 9 of Appendix B). This condition may be a result of slight movements in the backfill behind the right (north) wing wall. Presently, this condition is not a safety hazard but movements should be monitored for preventative maintenance.

2.4 PROJECT OPERATION AND MAINTENANCE

Newlan Creek Dam is owned and operated by the Newlan Creek Water District. The project was built as a multipurpose facility providing benefits primarily for irrigation, flood control, and recreation. An operation plan has been written, but a copy was not available for review. Storage and releases from the reservoir are generally dictated by seasonal factors. The late-spring and early-summer runoff is stored to the maximum level possible to accommodate irrigation water requirements which occur during the summer and early fall months, while still providing for fish flow requirements. The joint use pool is to be held available for flood storage until May 1 unless stream flow forecasts on April 1 indicate little or no likelihood of flow from snowmelt.

During the inspection, it was found that the guardian gate operation is quite cumbersome. The hydraulically controlled gate operation is slow, requires considerable familiarity of the system by the operator and lacks adequate operating instructions. The operating gates in the valve control box are functional and require minimum maintenance. Maintenance on the outlet works was required in 1978. Repairs included cradling the irrigation outlet steel pipe manifold in concrete, adding a joint block to the 42-inch concrete pipe/steel pipe adapter coupler and

flexible coupler, and installing additional drainage. A corrugated metal access riser was installed over the pressure manhole that was installed during the original construction (Correspondence, Appendix E). Conversation with the SCS subsequent to the June 1980 investigation indicates the hydraulic operating system on the guardian gate is no longer operable and the gate has been blocked and chained open to permit irrigation water releases.

The principal spillway is an uncontrolled facility, with the exception of the small gate and pipe attachment which allow some regulation. The owner/operator indicates that water has never overtopped the low stage box inlet. Maintenance was performed on the spillway in 1979 to repair buckling of the spillway chute caused by embankment settlement.

The emergency spillway is also an uncontrolled system. The owner/operator indicates the spillway has never operated. No maintenance has been performed on the system since construction in 1977.

Regular, organized inspections of Newlan Creek Dam have not historically been performed, and inspection records have not been kept. The project is inspected on an incidental basis in that the dam manager is commonly in the vicinity operating the control gate and/or taking pool elevation measurements. The gate controls would probably be inaccessible during a flood large enough to require emergency spillway operation.

There is no formal warning system or plan of action in the event of dam distress. Though not in the form of a plan of action, the residences downstream of the dam would be alerted by radios, phone, or door-to-door communication.

CHAPTER 3
FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

Visual inspection of the dam, supplemented by analysis of the project in accordance with the guidelines (Ref. 1) and the contract performance standards, resulted in the following findings.

3.1.1 Size, Hazard Classification and Safety Evaluation

In accordance with the inspection guidelines (Ref. 1), Newlan Creek Dam is classified large in size and, based on our visual inspection and engineering judgment, it has a high downstream hazard potential. Therefore, the guidelines' recommended spillway design flood (SDF) for this project is 100 percent of the PMF. Based on reconnaissance level investigations, the project is incapable of handling a flood having one-half of the PMF ordinates without overtopping and causing the dam to fail which, in our judgment, could seriously jeopardize life and property downstream. Under the inspection criteria, Newlan Creek Dam is considered unsafe, non-emergency until the recommended actions are complete.

3.1.2 Spillway

Newlan Creek Dam has both a principal spillway and an emergency spillway.

3.1.2.1 Principal Spillway

The principal spillway was recently repaired to correct damages resulting from embankment settlements. Currently, the spillway appears to be in good operating condition. Some cracking and chipping of the concrete is taking place at the box inlets and in the bridge area. Throughout the spillway, the small animal guards on drain outlets have been removed. The stilling basin appears to be in good condition, except the wing walls are displaced as much as several inches at the top. Because of the settlement damage experienced within the short period of time since original construction, close monitoring is suggested. Maximum spillway capacity, assuming the reservoir pool is at the first overtopping dam crest elevation (5282.4 feet NGVD) is approximately 3870 cfs. The flood storage between the principal spillway crest elevation (5272.5 feet NGVD) and the emergency spillway crest elevation (5278.3 feet NGVD) is 1970 AF.

3.1.2.2 Emergency Spillway

The emergency spillway is in good condition. Sloughing has occurred on the terraced hillside (south slope), but is not a problem at this time. Flood surcharge between the emergency spillway crest and the first overtopping elevation is 1400 AF. Maximum spillway capacity to the first dam crest overtopping elevation is 1390 cfs.

3.1.3 Outlet Works

Due to inaccessibility at the time of the survey, and the lack of necessary equipment to inspect a complex system such as this, a complete inspection of the irrigation outlet system was not possible. However, a cursory inspection of the valves and their operation was made. It was not possible to get a complete seal of the 42-inch diameter guardian gate. It was speculated that a rock was lodged in the gate frame. The three 24-inch diameter gate valves are functional, but the north and south valves require additional packing material. Conversation with the SCS subsequent to the June 1980 inspection indicates that the hydraulic operator for the guardian gate is inoperable, and the gate is now blocked and chained open to permit irrigation releases. Outlet works capacity to the first dam crest overtopping elevation (5282.4 feet NGVD) is 108 cfs.

3.1.4 Dam

The Newlan Creek Dam embankment appears stable and in good condition. However, the calculated design safety factor for the steady state seepage condition is below that recommended in the guidelines. In addition, the measured phreatic surface appears to be higher than the surface used in the design calculations and there is some erosion on the downstream face of the dam.

Some slope stability problems exist in the emergency spillway and irrigation outlet channel cut slopes. Small pop-outs have occurred in the emergency spillway on the terraced hillside. Periodic maintenance will be necessary to clean the emergency channel. The overall stability of the terraced hillside appears good. However, slope stability calculations were not available for review. Sloughing in the irrigation outlet does not create a safety hazard as construction of the irrigation system is not complete and the channel is not being used.

Settlement within the embankment appears to be a problem. The chute spillway was repaired in 1979 as a result of damage due to embankment settlements. Additional settlements are expected, but it is anticipated that they will occur less rapidly and with less magnitude. Settlements since the 1979 repairs are evident by

displacement of the drain pipe and in the backfill of the chute spillway. Movements in the wing wall of the chute spillway stilling basin are also evident.

3.1.5 Operation and Maintenance

There are no formal maintenance programs, and there are no regular, organized inspections. Evidently there is a project operation plan, but it was not available for review. Project operation is generally performed according to seasonal requirements. Major repairs and maintenance items have generally been performed by the SCS when necessary. Newlan Creek Dam is visited regularly throughout the irrigation season by the dam manager, and only occasionally during other periods.

3.2 RECOMMENDATIONS

Due to storage between normal pool and dam crest, the present project provides a degree of flood protection to the downstream area. The intent of report recommendations is to maintain or improve project safety, if feasible, without decreasing the existing flood protection.

1. Immediately develop, implement, and periodically test an emergency warning plan for use in the event of dam distress.

2. Perform the following repairs on the outlet works facility: determine the problem(s) with the guardian gate and make the necessary repairs; repack the gate stems for the operating valves where necessary to eliminate leaking; and repair/replace the 4-inch gate valve in the valve control box. Inspect the total length of the conduit and repair as necessary.

3. Regrade the dam crest and the berms on the downstream face of the dam where erosion is occurring to eliminate runoff concentrations down the face. Study the feasibility of seeding the existing surface soils to reduce erosion.

4. Perform the following repairs on the principal spillway: repair concrete chipping and cracking in the drop box inlets and chute where necessary; replace the small animal guards over the drain outlets in the spillway sidewalls; and redistribute the rock riprap along the right (north) stilling basin wing wall.

The above recommendations will not make the project safe but will reduce involved risks while the following recommendations, with subsequent actions, are being accomplished.

5. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity and modify the project as studies indicate.

6. Reevaluate the embankment slope stability for maximum measured piezometer levels to verify stability of the downstream slope.

7. Improve the operating procedure for the guardian gate controls, and provide concise and understandable operating instructions in the valve pit.

8. Develop an active monitoring program to observe and evaluate the following features: the soil sloughing on the emergency spillway terraced slope and at the unfinished irrigation outlet channel; movements of the principal spillway chute and riprap behind the wing walls at the stilling basin; elevation changes of the dam crest and bridge across the spillway chute; and piezometer readings to establish an on-going history of the phreatic surface through the embankment for different hydraulic loading conditions.

9. Conduct periodic inspections by qualified engineers at least once every five years to determine whether there are any deficiencies in the condition of the project, to assess the adequacy and quality of maintenance, and to evaluate methods of operation. Include an inspection of the total length of the conduit through the embankment in this program.

10. Develop and implement a periodic maintenance plan for the dam and appurtenant structures.

Prior to performing engineering studies and remedial construction, coordinate the work with the Montana DNRC, Dam Safety Section, to insure compliance with all pertinent laws and regulations.

REFERENCES

1. U.S. Army Corps of Engineers, Office of the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams". Washington, D.C., Department of the Army, May 1975.

2. U.S. Geological Survey, 7-1/2 Minute Quad Map, Coxcombe Butte, Montana, 1971.

3. U.S. Geological Survey, White Sulphur Springs, Montana, AMS, Scale 1:250,000, 1958 with revision 1972.

4. U.S. Soil Conservation Service, Newlan Creek Dam Design Files, Bozeman, Montana.

5. Groff, S.L., Reconnaissance Groundwater and Geologic Studies of Western Meagher County, Montana, Montana Bureau of Mines and Geology, Special Publication 35, 1965.

6. Von Hake, C.A., Earthquake Information Bulletin, USGS, Vol. 10, No. 4, 1978.

7. National Oceanic and Atmospheric Administration, Climatological Data, Montana, National Climatic Center, Asheville, N.C.

8. National Oceanic and Atmospheric Administration, Climates of the States, Volume II, "Western States Including Alaska and Hawaii", Port Washington, N.Y., 1974.

9. U.S. Bureau of Reclamation, Design of Small Dams, 2nd. Edition, 1973, Revised Reprint, 1974.

10. Department of Planning and Economic Development, State of Montana, "Comprehensive Area-Wide Water and Sewer Plan, 1970, State of Montana, Meagher County, 1971.

11. National Weather Service, Interim All-Season Probable Maximum Precipitation Estimates, Missouri River Drainage West of the 105th Meridian, January 1, 1980.

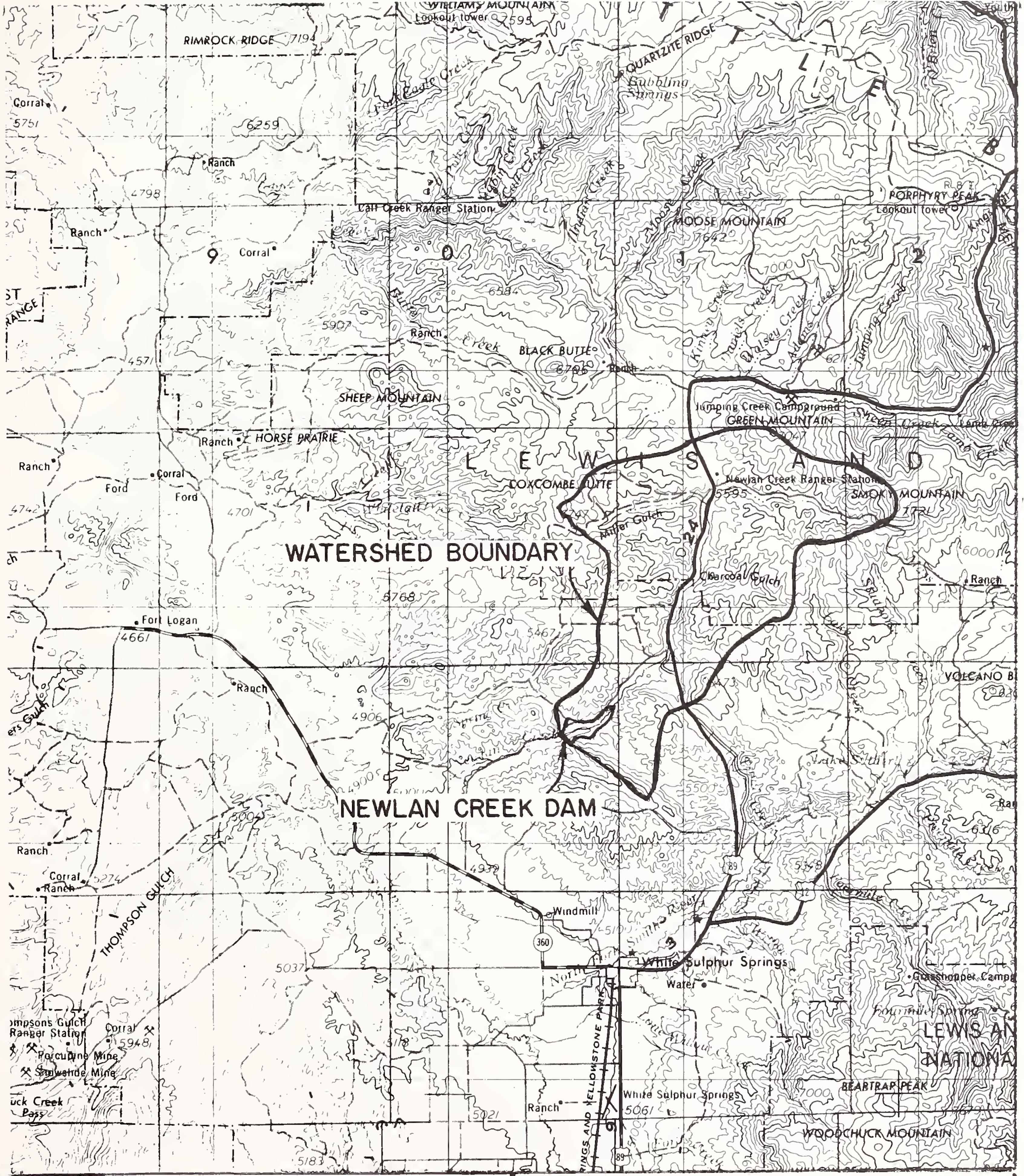
12. National Weather Service, Hydrometeorological Report No. 43, Probable Maximum Precipitation, Northwest States, Washington, D.C., 1966.

13. U.S. Soil Conservation Service, National Engineering Handbook, Section 4, "Hydrology", Washington, D.C., 1969.

14. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Davis, California, September, 1978.

APPENDIX A

VICINITY & WATERSHED MAP



SOURCE: WHITE SULPHUR SPRINGS, MONTANA
AMS MAP, USGS

APPENDIX A

VICINITY & WATERSHED MAP

NEWLAN CREEK DAM

APPENDIX B

INSPECTION PHOTOS

Photo No. 1 - Upstream Watershed.
The upstream watershed is comprised of foothills and mountains of the Little Belt Range.

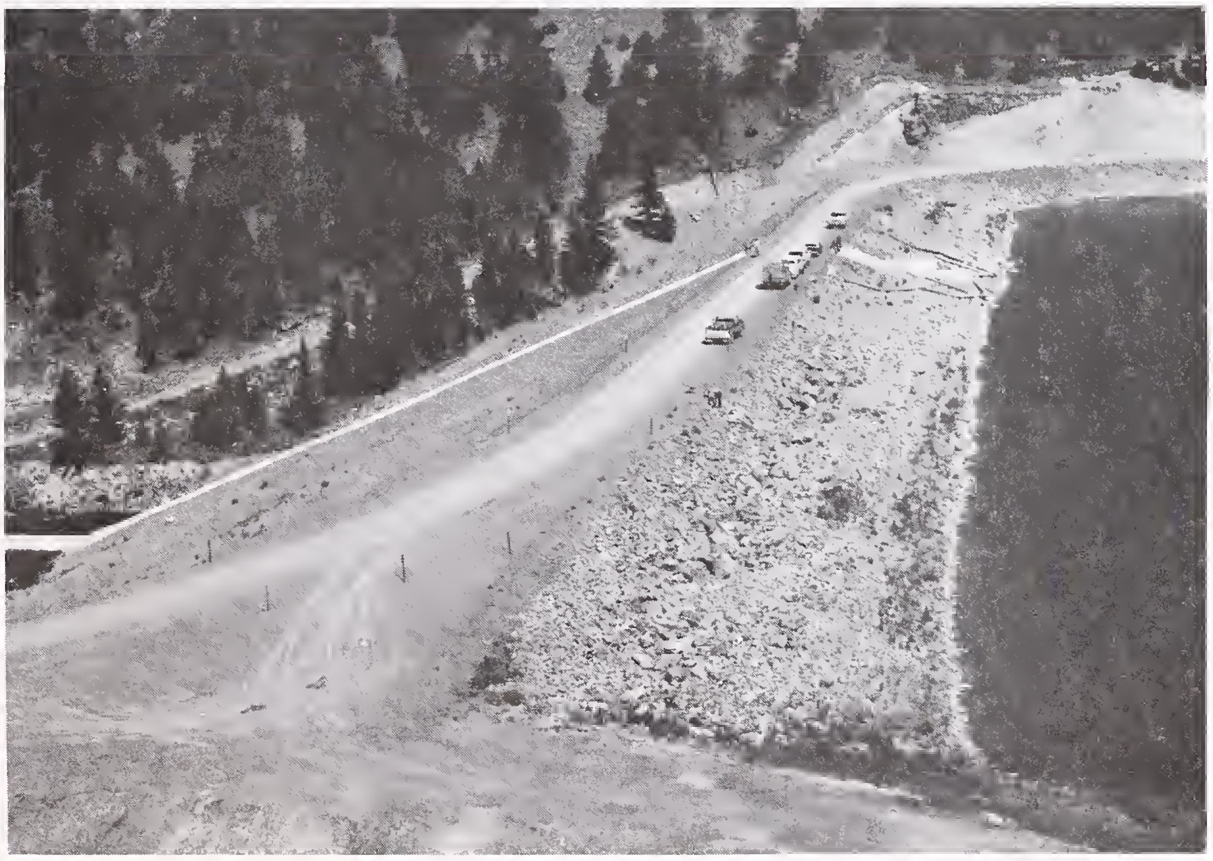


Photo No. 2 - Dam Embankment.
The upstream side of the dam embankment is shown.

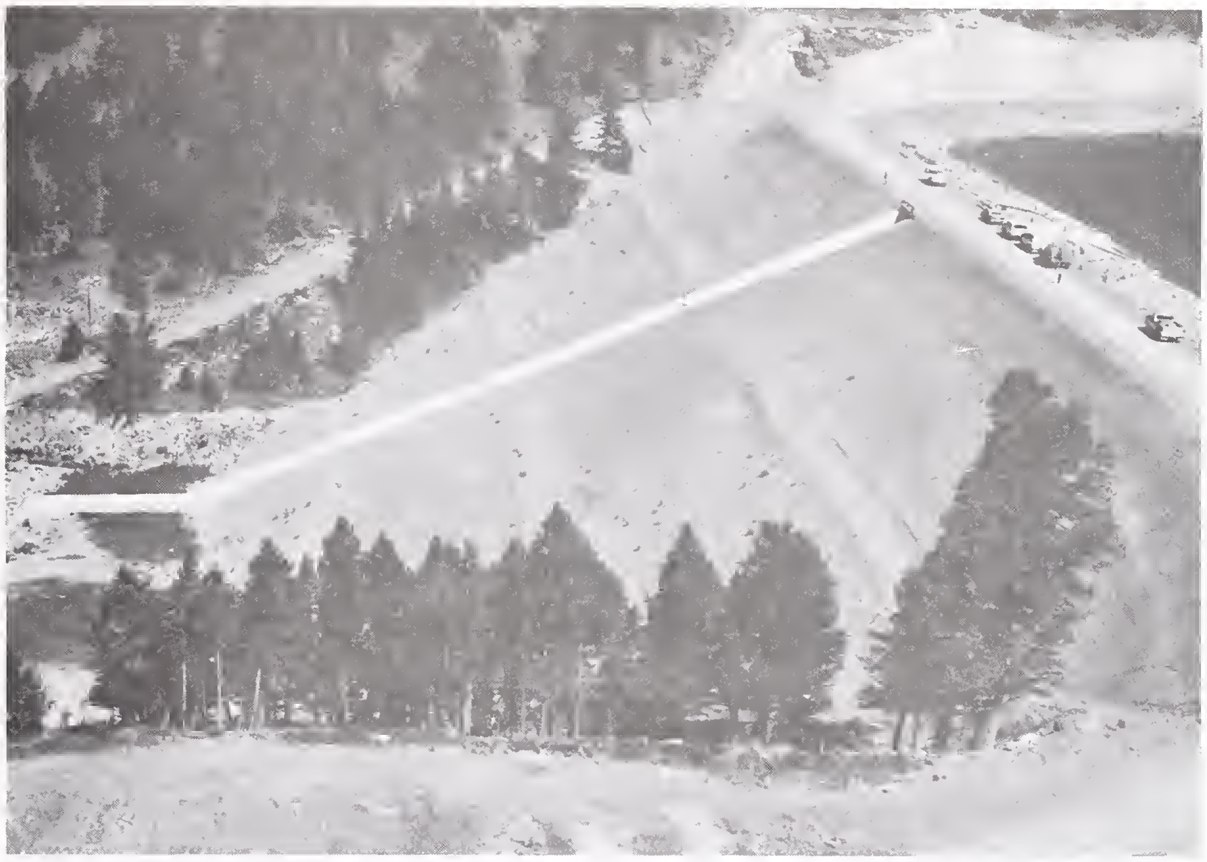


Photo No. 3 - Dam Embankment.
Shown is the downstream face of the dam embankment.

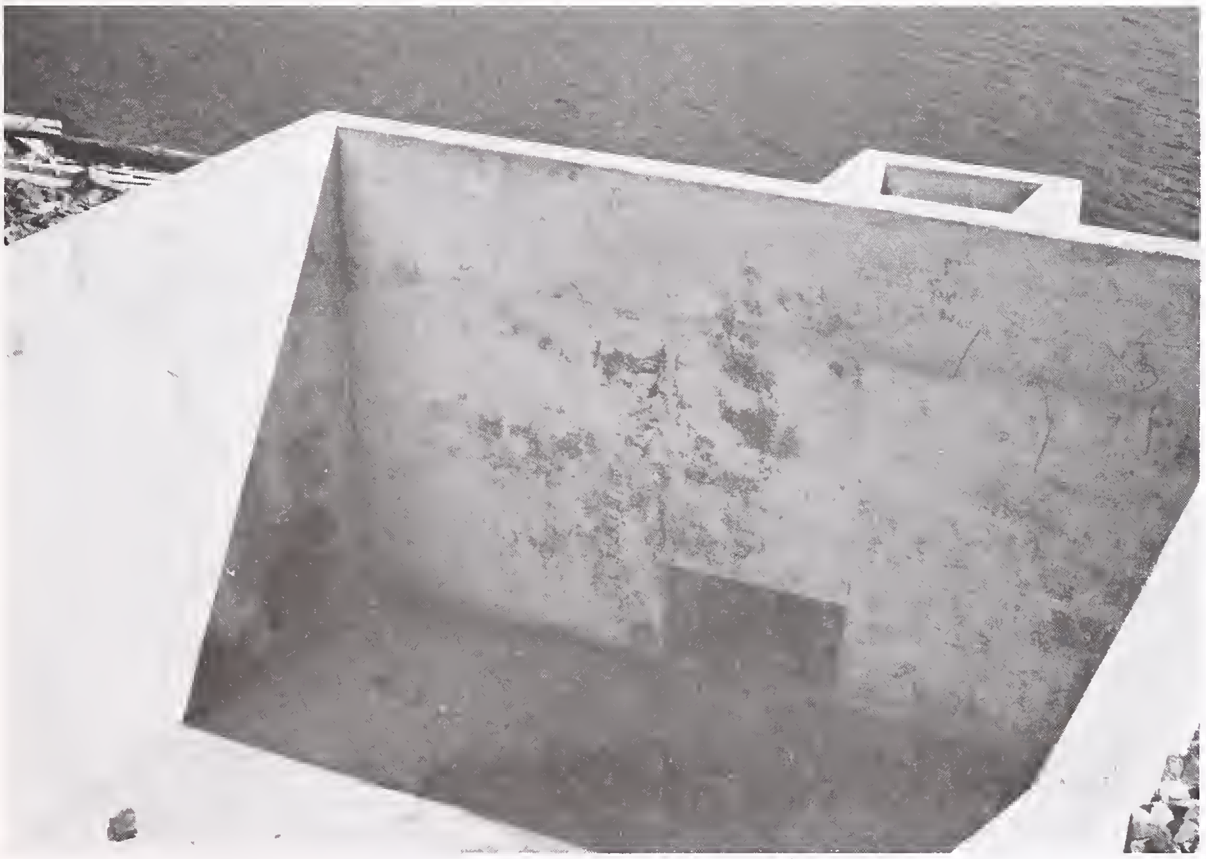


Photo No. 4 - Principal Spillway.
The principal spillway has two box inlets. The circular pipe visible in the box is part of the joint pool drawdown structure.

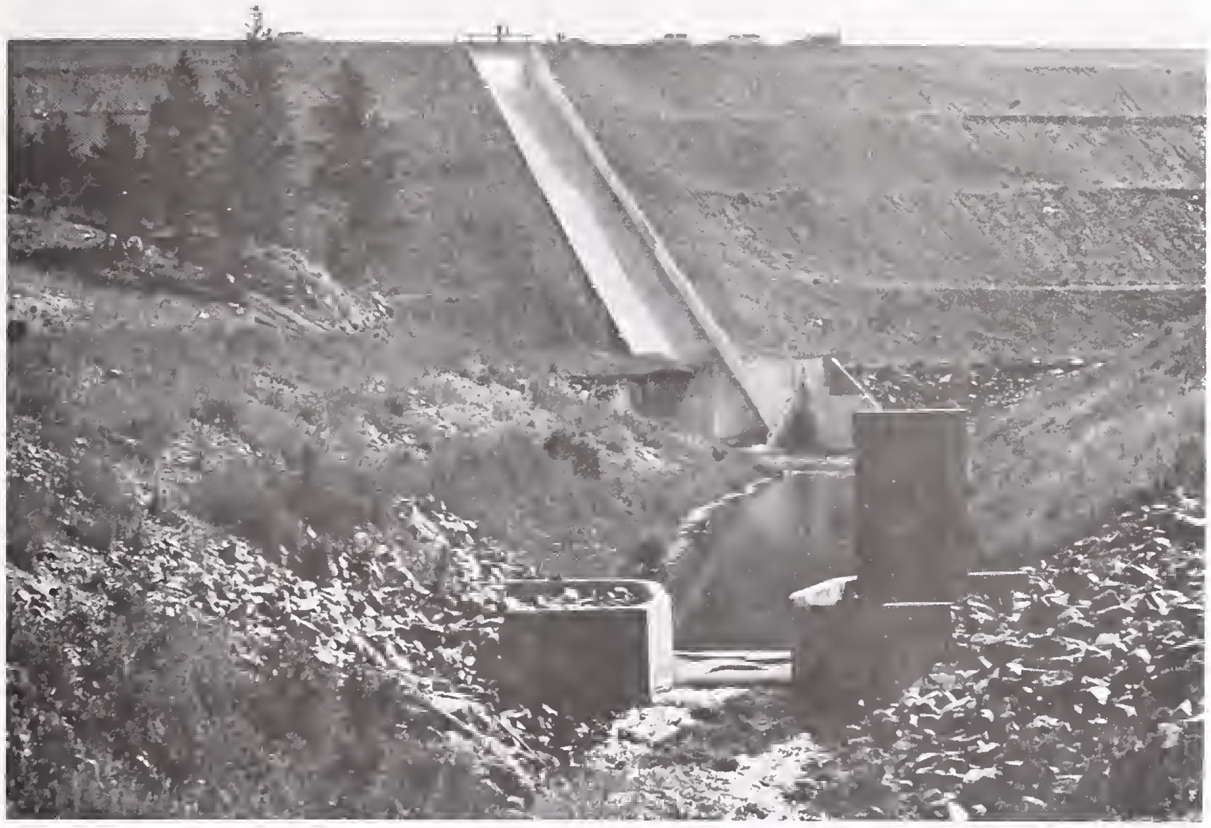


Photo No. 5 - Principal Spillway.
The principal spillway chute is located on the downstream face of the dam. The outlet works, shown flowing, and the principal spillway share the stilling basin. The Parshall flume is shown in the foreground.

Photo No. 6 - Emergency Spillway.
The rock emergency spillway is located on the left abutment.

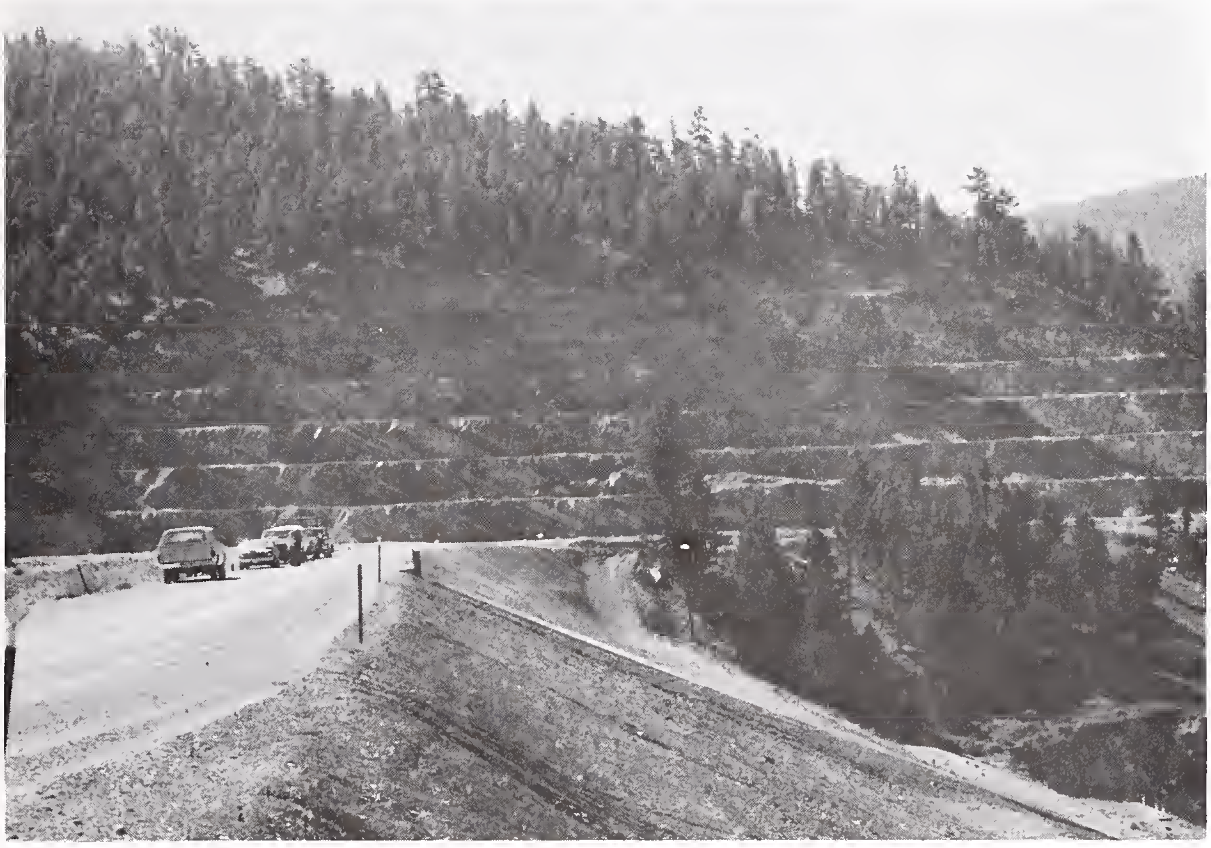


Photo No. 7 - Emergency Spillway.
Sloughing is occurring on the terraced left abutment of the emergency spillway.

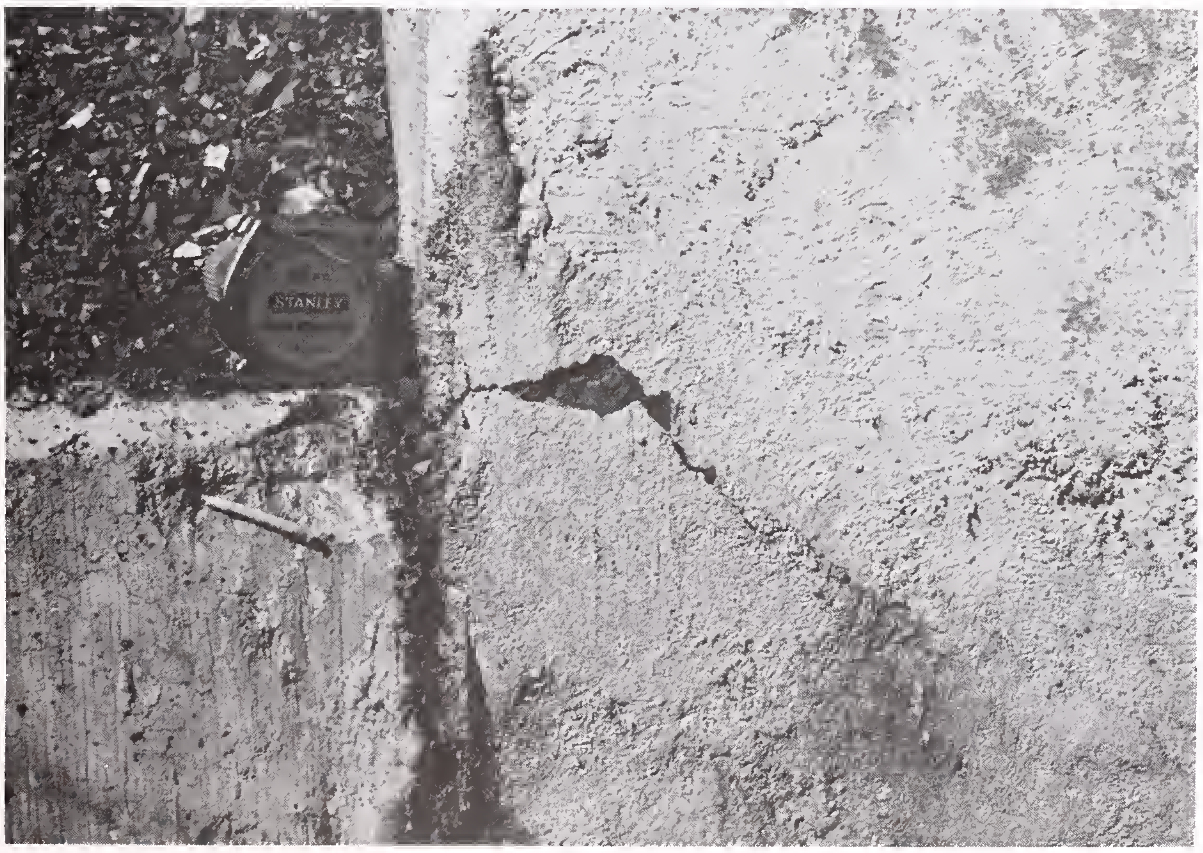


Photo No. 8 - Principal Spillway.
Cracking is present in the left wall of the principal spillway at the upstream side of the bridge.

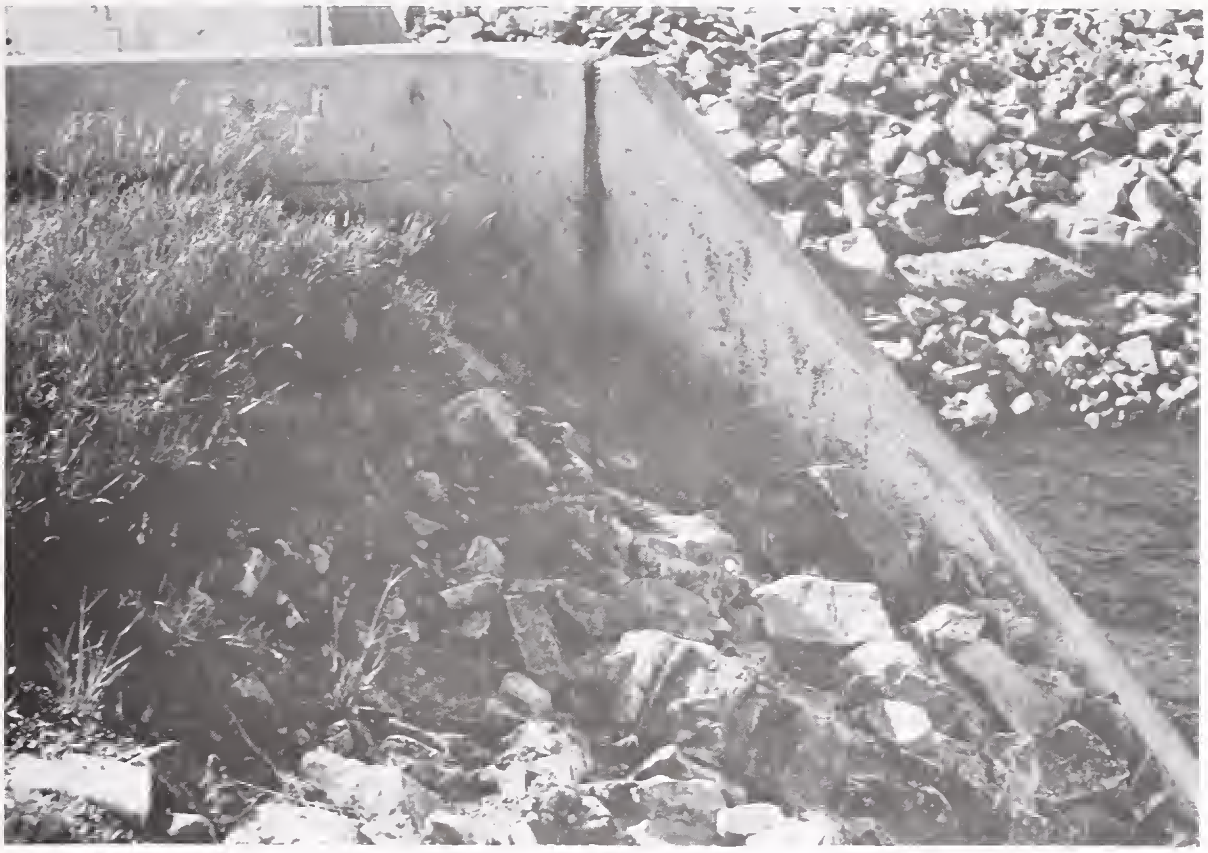


Photo No. 9 - Principal Spillway.
Both wingwalls in the stilling basin are displaced.

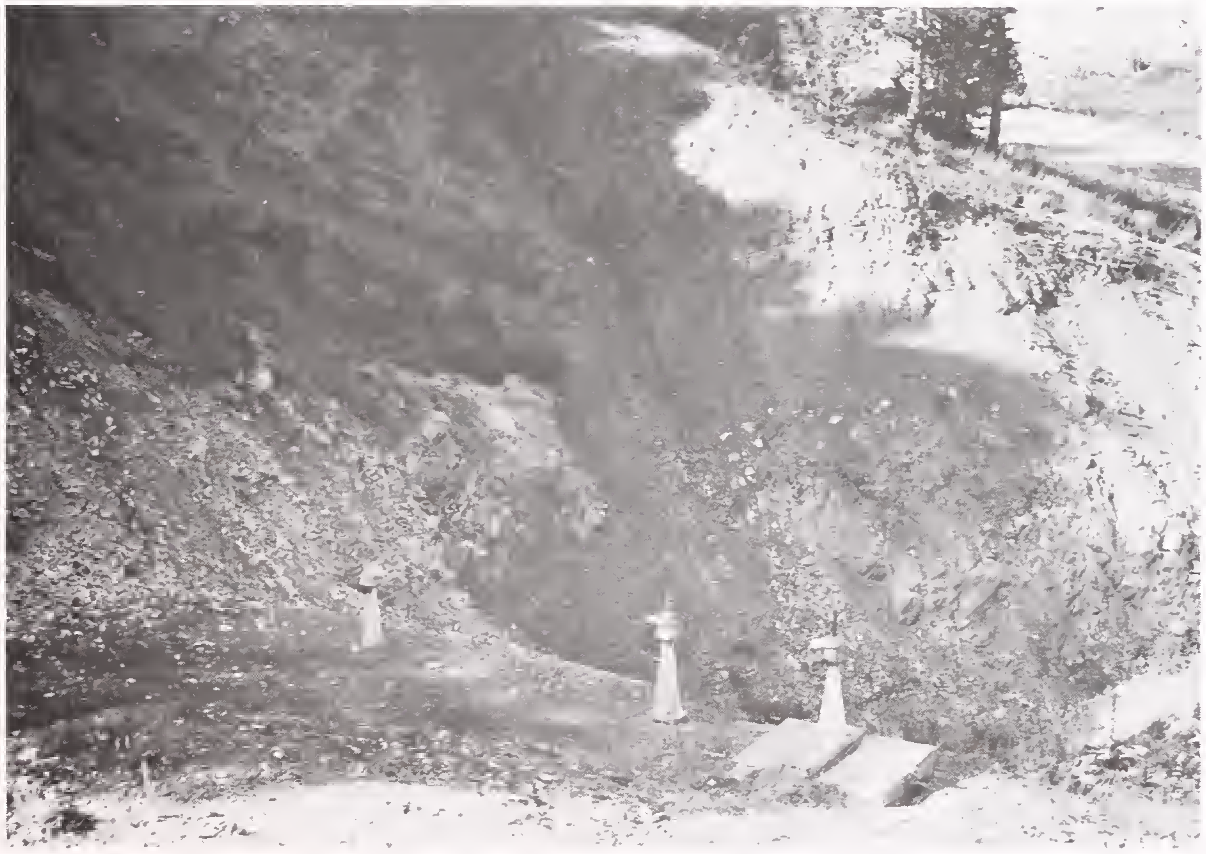


Photo No. 10 - Outlet Works.
Sloughing is taking place around the blind flanges downstream of the valve control box.

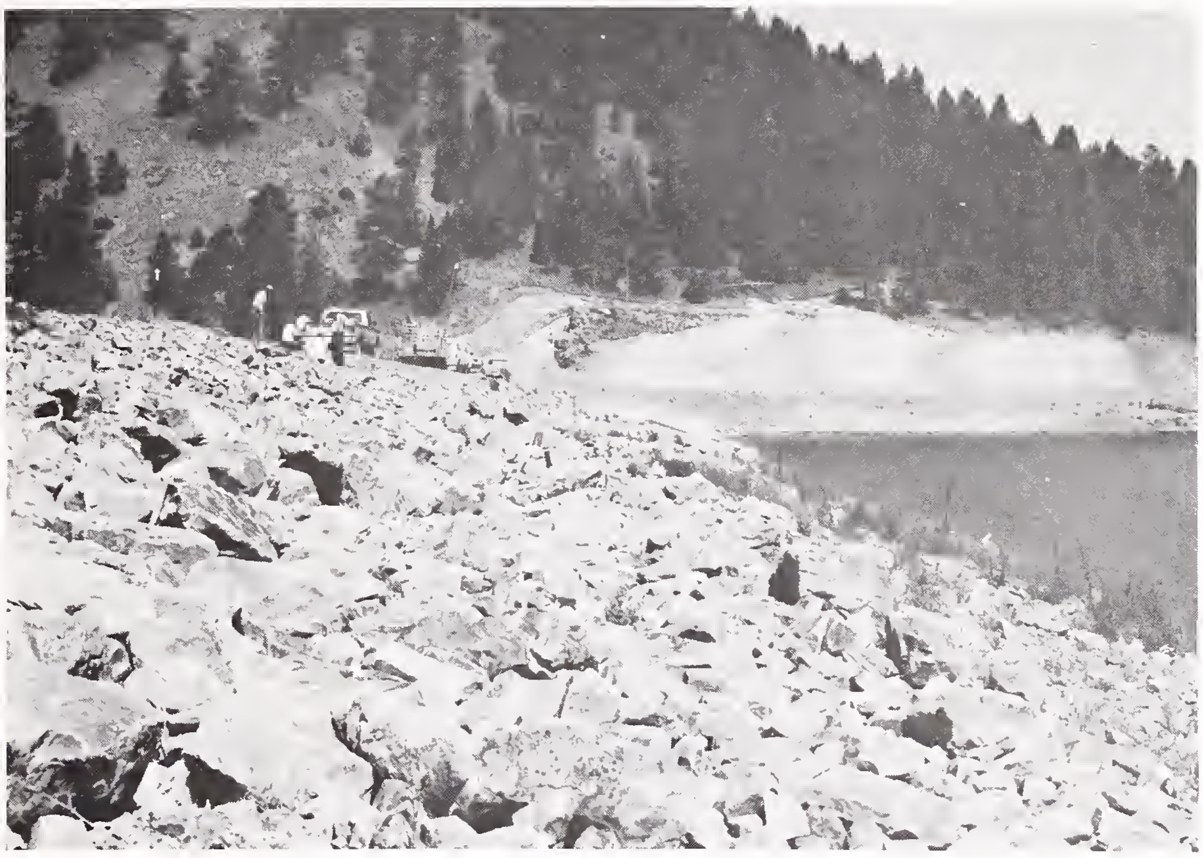
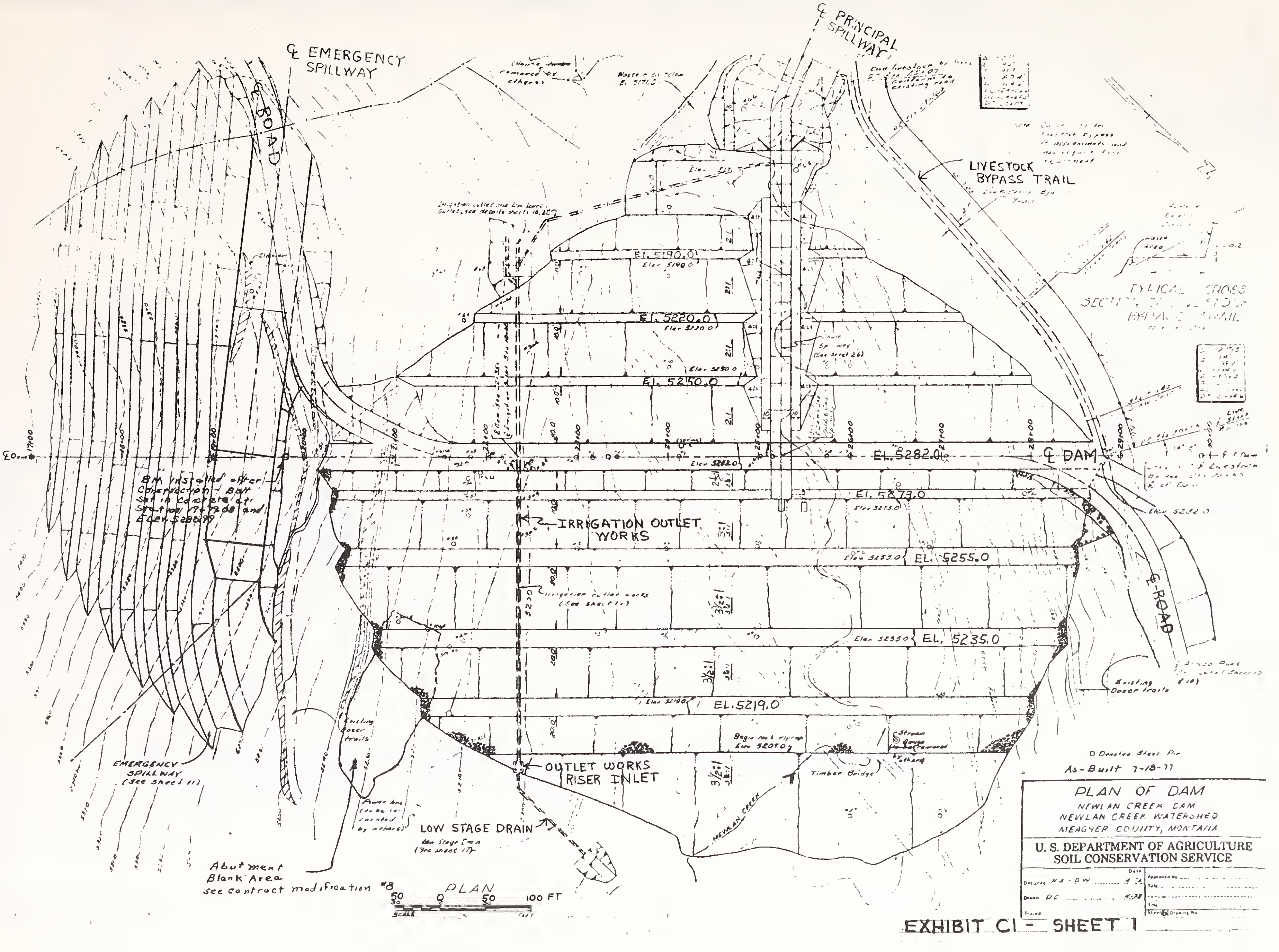


Photo No. 11 - Dam Embankment.
Rock riprap on the upstream face of the dam is in good condition.

APPENDIX C

PROJECT DRAWINGS

Exhibit C1	Construction Plans
Exhibit C2	Dam Crest Profile
Exhibit C3	Measured Embankment Slopes
Exhibit C4	Piezometer Readings & Approx. Phreatic Surface
Exhibit C5	Soil Design Data



℄ EMERGENCY SPILLWAY
℄ ROAD
℄ PRINCIPAL SPILLWAY
(House ~~area~~ removed by others)
Waste area below E. 5171.0
End livestock bypass trail
LIVESTOCK BYPASS TRAIL
TYPICAL CROSS SECTION OF LIVESTOCK BYPASS TRAIL
Irrigation outlet and Low level Outlet, see details sheets 16,22
EL. 5190.0
Elev 5190.0
EL. 5220.0
Elev 5220.0
Elev 5250.0
EL. 5250.0
Chute Spillway (See sheet 26)
℄ Dam
17+00
18+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
EL. 5282.0
Elev 5282.0
℄ DAM
EL. 5273.0
Elev 5273.0
Elev 5282.0
BM installed after Construction - Bolt Set in Concrete at Station 17+72.08 and Elev 5280.99
IRRIGATION OUTLET WORKS
Irrigation outlet works (See sheet 16)
Elev 5255.0
EL. 5255.0
℄ ROAD
Elev 5235.0
EL. 5235.0
Existing Dozer trails
Elev 5219.0
EL. 5219.0
Begin rock riprap Elev 5207.0
Stream Gauge (removed by others)
Timber Bridge
NEWLAN CREEK
OUTLET WORKS RISER INLET
LOW STAGE DRAIN
Low Stage Drain (See sheet 17)
Existing Dozer trails
Power line (to be relocated by others)
EMERGENCY SPILLWAY (See sheet 11)
Abutment Blank Area see contract modification #8
2:1
4:1
3:1
3½:1
PLAN
50 0 50 100 FT
SCALE
N

D Denotes Steel Pin

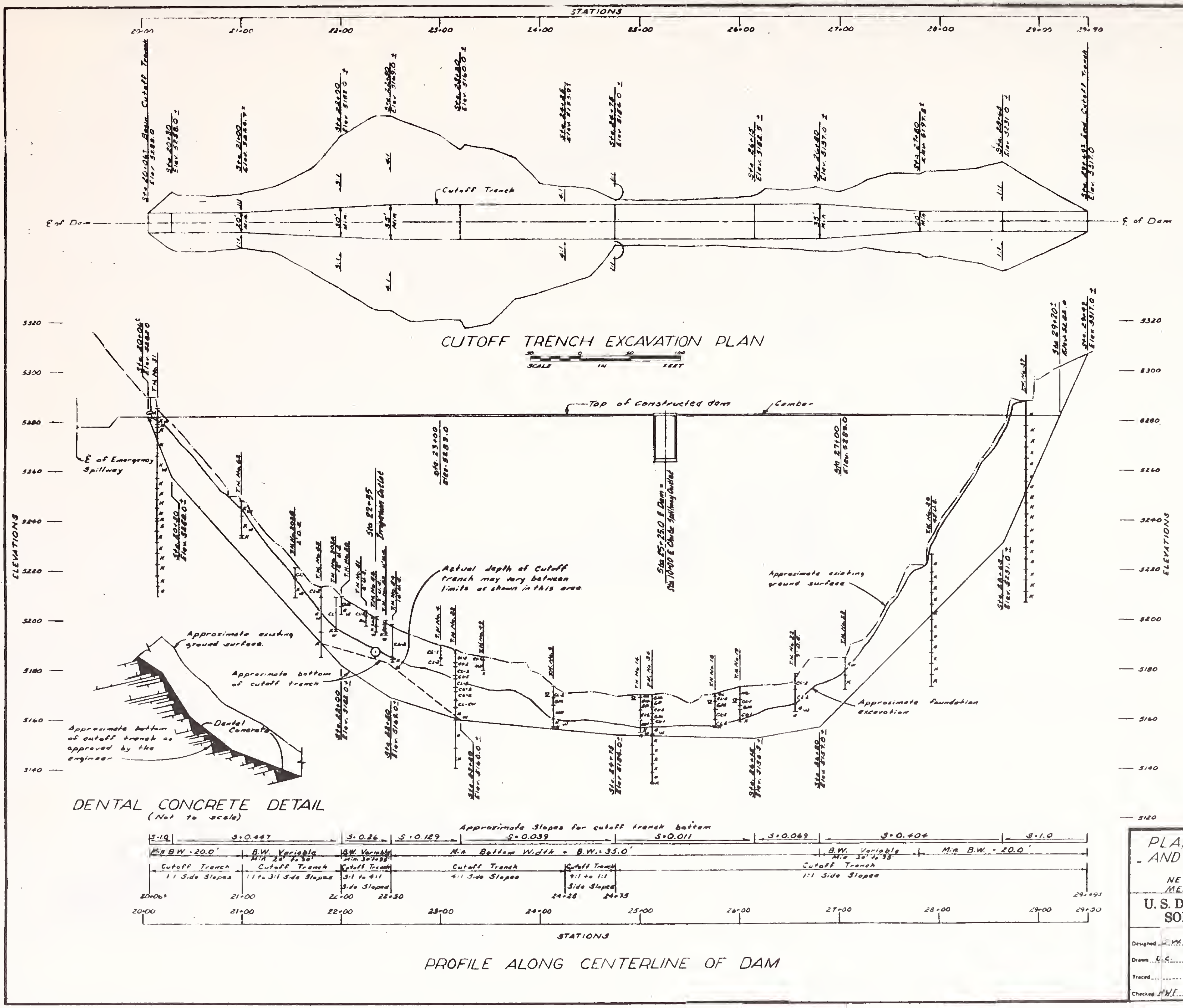
As-Built 7-18-77

PLAN OF DAM
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R.S. - D.W. Date 4-74
Drawn D.C. 4-74
Traced
Approved by
Title
Title
Sheet 6 Drawing No

EXHIBIT C1 - SHEET 1


STATIONS
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
29+90
℄ of Dam
℄ of Dam
Cutoff Trench
Sta 20+06± Begin Cutoff Trench
Sta 29+49± End Cutoff Trench
Sta 20+30 Elev. 5280.0 ±
Sta 21+00 Elev. 5226.4 ±
Sta 22+00 Elev. 5182.0 ±
Sta 22+50 Elev. 5169.0 ±
Sta 23+80 Elev. 5160.0 ±
Sta 27+80 Elev. 5197.8 ±
Sta 28+64 Elev. 5231.0 ±
20' Min
30' Min
35' Min
1:1
3:1
4:1
ELEVATIONS
5320
5300
5280
5260
5240
5220
5200
5180
5160
5140
5120
℄ of Emergency Spillway
Top of Constructed dam
Camber
Sta 23+00 Elev. 5283.0
Sta 27+00 Elev. 5283.0
Sta 25+25.0 ℄ Dam = Sta 10+00 ℄ Chute Spillway Outlet
Sta 22+95 Irrigation Outlet
Sta 29+20± Elev. 5288.0
Sta 29+49 Elev. 5317.0 ±
Actual depth of Cutoff trench may vary between limits as shown in this area.
Approximate existing ground surface
Approximate bottom of cutoff trench
Approximate foundation excavation
T.H. No. 31
T.H. No. 37
Approximate existing ground surface.
Dental Concrete
Approximate bottom of cutoff trench as approved by the engineer
SCALE IN FEET
50 0 50 100
Approximate Slopes for cutoff trench bottom
S=1.0
S=0.447
S=0.26
S=0.129
S=0.039
S=0.011
S=0.069
S=0.404
S=1.0
Min B.W. = 20.0'
B.W. Variable Min 20' to 30'
B.W. Variable Min 30' to 35'
Min Bottom Width = B.W. = 35.0'
B.W. Variable Min 20' to 35'
Min B.W. = 20.0'
Cutoff Trench 1:1 Side Slopes
Cutoff Trench 1:1 to 3:1 Side Slopes
Cutoff Trench 3:1 to 4:1 Side Slopes
Cutoff Trench 4:1 Side Slopes
Cutoff Trench 4:1 to 1:1 Side Slopes
Cutoff Trench 1:1 Side Slopes
20+06±
21+00
22+00
22+50
24+28
24+75
29+49±
29+50
STATIONS
N

CUTOFF TRENCH EXCAVATION PLAN

PROFILE ALONG CENTERLINE OF DAM

DENTAL CONCRETE DETAIL
(Not to scale)

LEGEND

CL	Clays of low liquid limit and medium plasticity: silty, sandy or gravelly clays and clayey silts.
CL-1	Clays of low to medium plasticity.
CL-2	Clays of medium to high plasticity.
GM	Silty gravels; gravel-sand-silt mixtures.
GP	Poorly graded gravels.
CH	Inorganic clays of high liquid limit and high plasticity; fat clays and silty clays.
MH	Elastic silts; and plastic silts.
ML	Silts; silty, very fine sands; sandy or clayey silts.
OL	Organic silts and organic silty clays of low liquid limit and low plasticity.
Kw	Bedrock, (Argillites) weathered
K	Bedrock (Argillites)
∇	Water table on date of drilling as shown in Complete field logs.

NOTES: 1. All logs are abridged and shown for bidders information. Complete field logs, geology report, and laboratory test reports are available for prospective bidders study at the office of the Contracting Officer.

2. Grades as shown are for initial staking to establish the top width of the cutoff trench. Final depth of cutoff trench excavation will be determined in the field by the engineer.

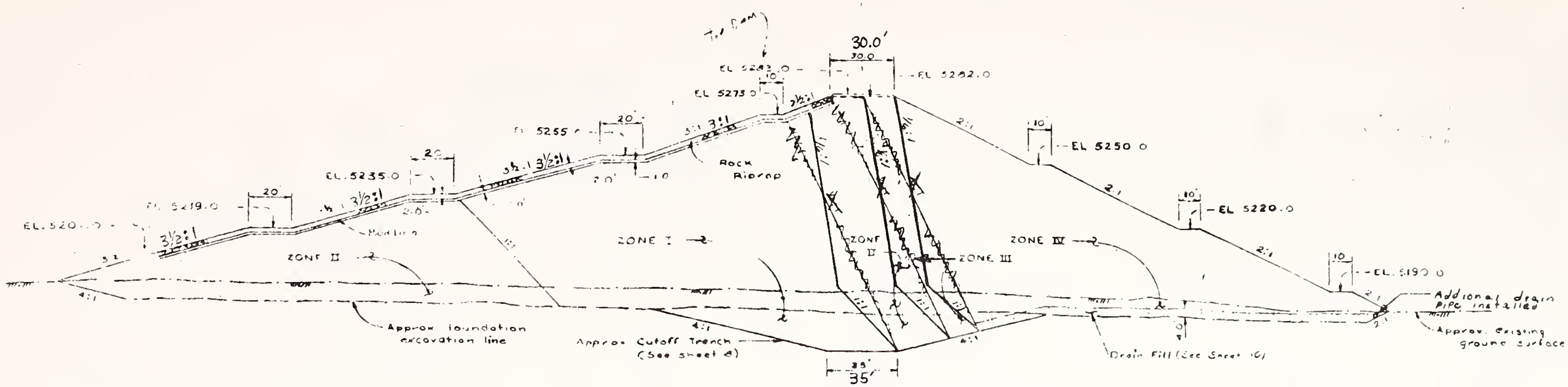
PLAN OF CUT OFF TRENCH
AND ℄ OF DAM PROFILE
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed B.W.	Date 4/73	Approved by	
Drawn D.C.	4/73	Title	
Traced		Title	
Checked PWE WHE	5-73	Sheet No. 8 of 48	Drawing No 7-E-22662

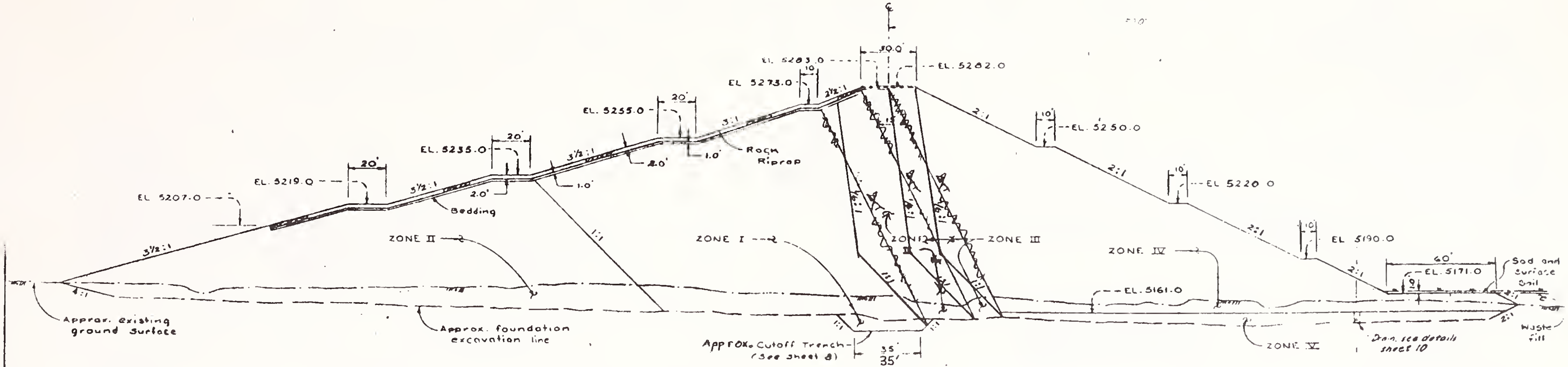
SCS-ENG-313-R Rev. 7-60

EXHIBIT C1 - SHEET 2



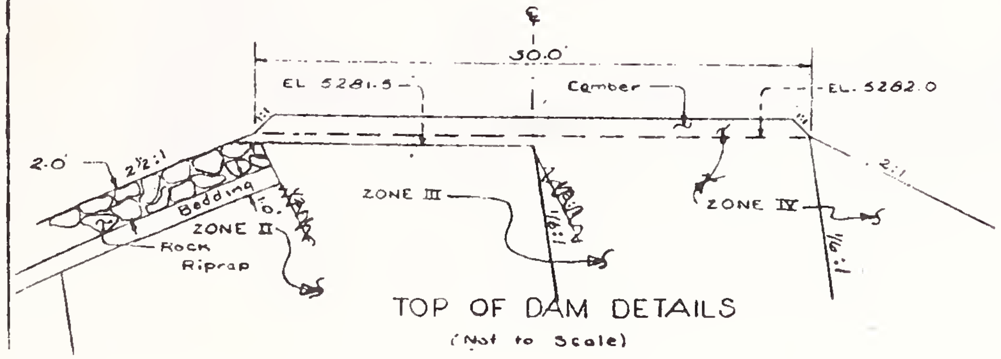
STA. 23+00

Note: Zone limits Changed. See
Contract Modification #7



STA. 24+75

30 0 30 60
SCALE IN FEET



TOP OF DAM DETAILS
(Not to Scale)

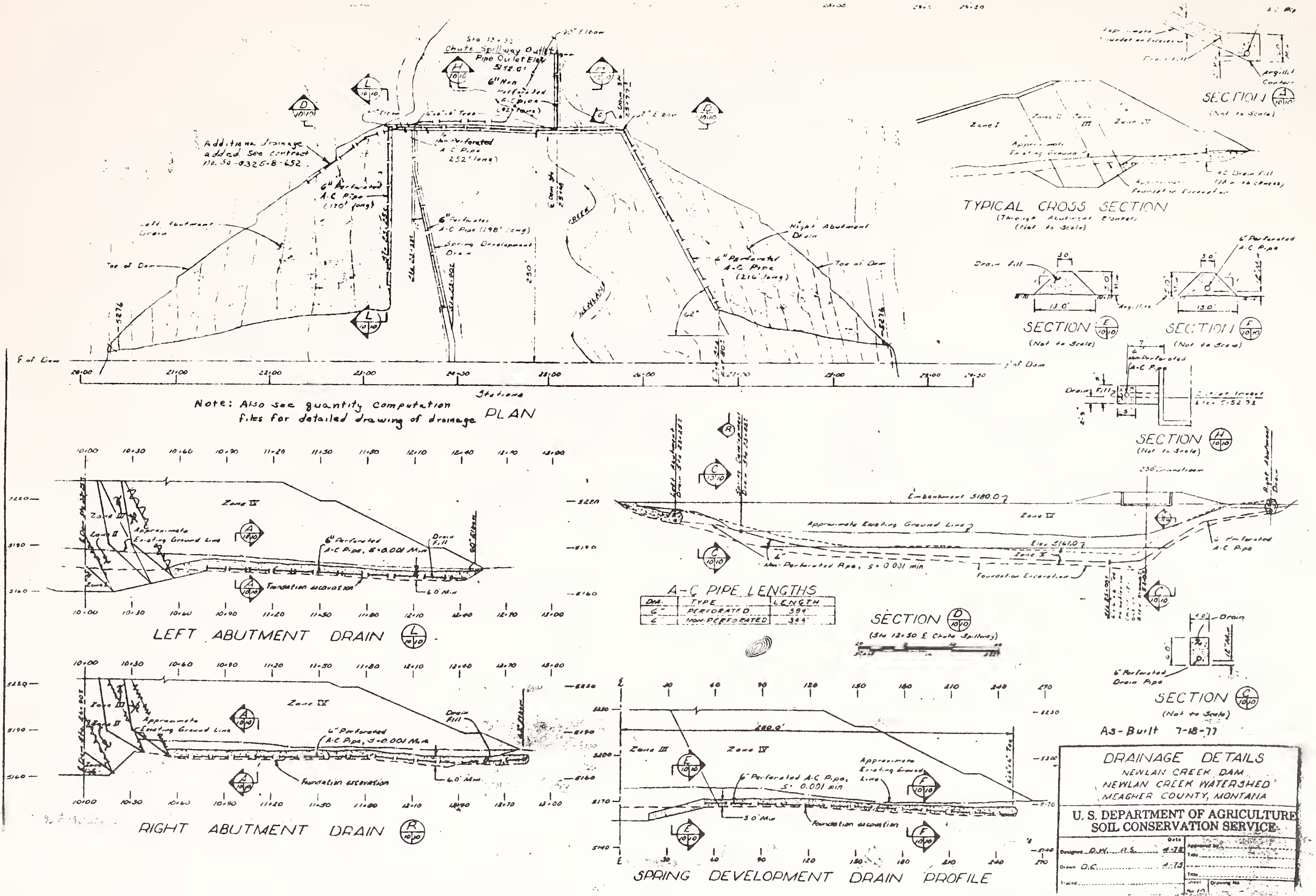
As-Built 7-18-77

TYPICAL CROSS SECTIONS OF DAM
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed R.S. - O.W.	4-73	Approved by
Drawn M.S.	5-73	Title

EXHIBIT C1 - SHEET 3



A-C PIPE LENGTHS

DIA.	TYPE	LENGTH
6"	PERFORATED	594'
6	NON-PERFORATED	344'

Note: Also see quantity computation files for detailed drawing of drainage

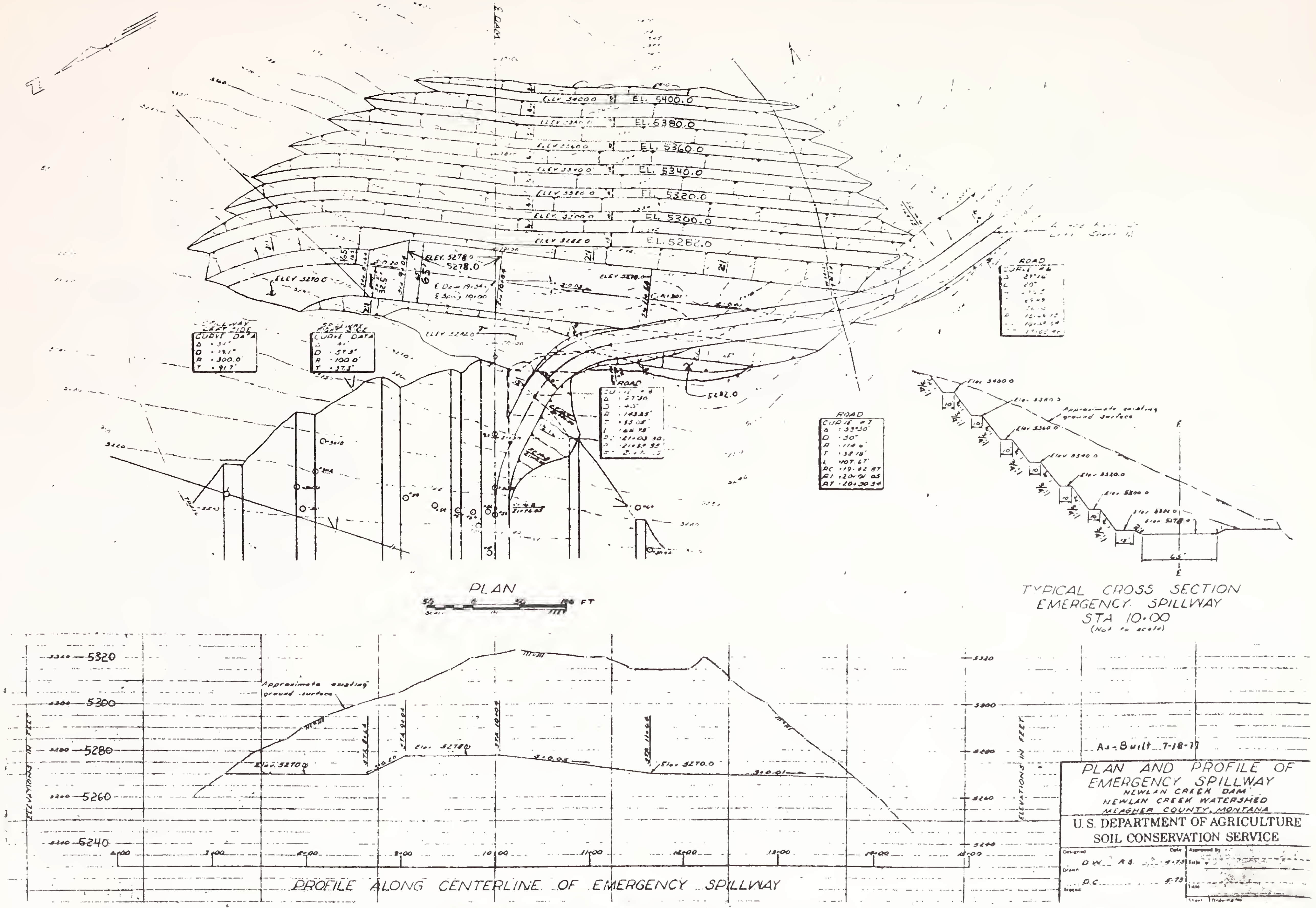
As-Built 7-18-77

DRAINAGE DETAILS
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

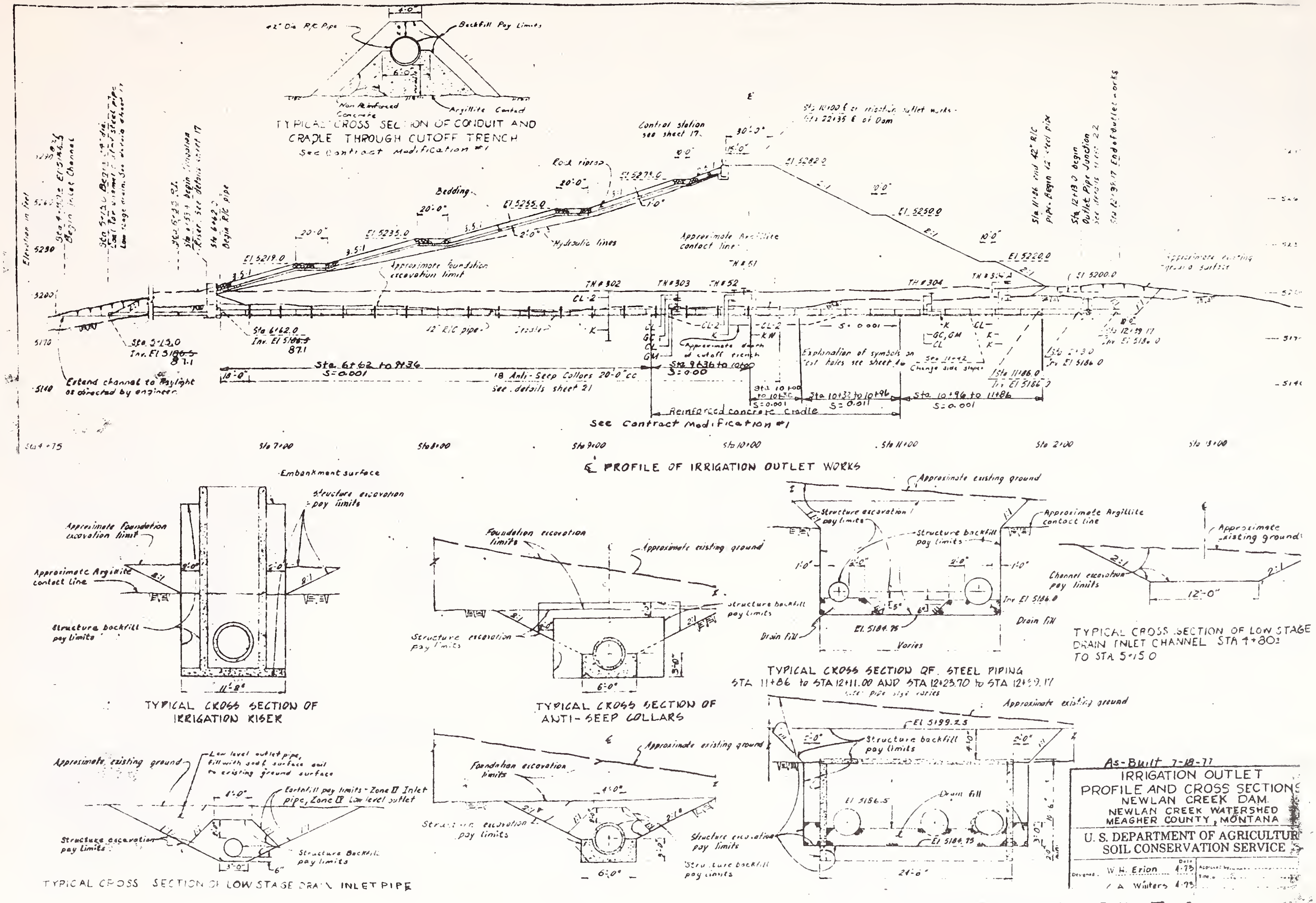
Designed D.W. A.S. Date 4-75
Drawn D.C. 4-75
Traced
Approved by
Title
Title
Sheet No 10
Drawing No

EXHIBIT C1 - SHEET 4



Note: Emergency Spillway Crest El. field measured El. 5278.3, 6/26/80

EXHIBIT C1- SHEET 5


TYPICAL CROSS SECTION OF CONDUIT AND CRADLE THROUGH CUTOFF TRENCH
See Contract Modification #1
42" Dia R/C Pipe
Backfill Pay Limits
Non Reinforced Concrete
Argillite Contact
4'-0"
6'-0"
℄ PROFILE OF IRRIGATION OUTLET WORKS
Elevation in feet
Sta 4+75 El 5186.5 Begin Inlet Channel
Sta 5+15.0 Begin 12" dia. Cast for channel & steel pipe Low stage drain. See details sheet 17
Sta 6+33.02 Sta 6+53.4 begin transition Riser. See details sheet 17
Sta 6+62.0 Begin R/C pipe
Sta 5+15.0 Inv. El 5186.5 87.1
Sta 6+62.0 Inv. El 5186.5 87.1
Extend channel to daylight as directed by engineer.
Sta 6+62 to 9+36 S=0.001
18 Anti-Seep Collars 20'-0" cc See details sheet 21
Sta 9+36 to 10+00 S=0.00
Sta 10+00 to 10+32 S=0.001
Sta 10+32 to 10+96 S=0.011
Sta 10+96 to 11+86 S=0.001
Reinforced concrete cradle
See Contract Modification #1
Explanation of symbols on test holes see sheet 4
Approximate depth of cutoff trench
Control station see sheet 17.
Sta 10+00 ℄ of irrigation outlet works. Sta 22+35 ℄ of Dam
Sta 11+86 end 42" R/C pipe. Begin 42" steel pipe
Sta 12+13.0 begin Outlet Pipe Junction See details sheet 22
Sta 12+39.17 End of outlet works
Rock riprap
Bedding
Hydraulic lines
Approximate foundation excavation limit
Approximate Argillite contact line
Approximate existing ground surface
12" R/C pipe
Cradle
El 5219.0
El 5235.0
El 5255.0
El 5275.0
El 5282.0
El 5250.0
El 5220.0
El 5200.0
3.5:1
2:1
20'-0"
2'-0"
1'-0"
10'-0"
15'-0"
30'-0"
TH #302
TH #303
TH #52
TH #51
TH #304
CL-2
GC, GM
CL
K
KW
Sta 11+86.0 Inv. El 5186.0
Sta 12+13.0 Inv. El 5186.0
Sta 12+39.17 Inv. El 5186.0
5230
5200
5170
5140
Sta 4+75
Sta 7+00
Sta 8+00
Sta 9+00
Sta 10+00
Sta 11+00
Sta 12+00
Sta 13+00
TYPICAL CROSS SECTION OF IRRIGATION RISER
Embankment surface
Structure excavation pay limits
Approximate foundation excavation limit
Approximate Argillite contact line
Structure backfill pay limits
2'-0"
11'-8"
2:1
TYPICAL CROSS SECTION OF ANTI-SEEP COLLARS
Foundation excavation limits
Approximate existing ground
Structure backfill pay limits
Structure excavation pay limits
6'-0"
3'-0"
TYPICAL CROSS SECTION OF STEEL PIPING STA 11+86 to STA 12+11.00 AND STA 12+23.70 to STA 12+39.17
Steel pipe size varies
Approximate existing ground
Structure excavation pay limits
Structure backfill pay limits
Approximate Argillite contact line
Inv El 5186.0
El. 5184.75
Drain fill
Varies
1'-0"
2'-0"
TYPICAL CROSS SECTION OF LOW STAGE DRAIN INLET CHANNEL STA 4+80± TO STA 5+15.0
Approximate existing ground
Channel excavation pay limits
12'-0"
2:1
TYPICAL CROSS SECTION OF LOW STAGE DRAIN INLET PIPE
Approximate existing ground
Low level outlet pipe, fill with sod & surface soil to existing ground surface
Earthfill pay limits - Zone II Inlet pipe, Zone IV Low level outlet
Structure excavation pay limits
Structure Backfill pay limits
4'-0"
3'-0"
6"
Foundation excavation limits
Structure excavation pay limits
Structure backfill pay limits
Approximate existing ground
El 5199.25
El 5186.5
El 5184.75
Drain fill
21'-0"

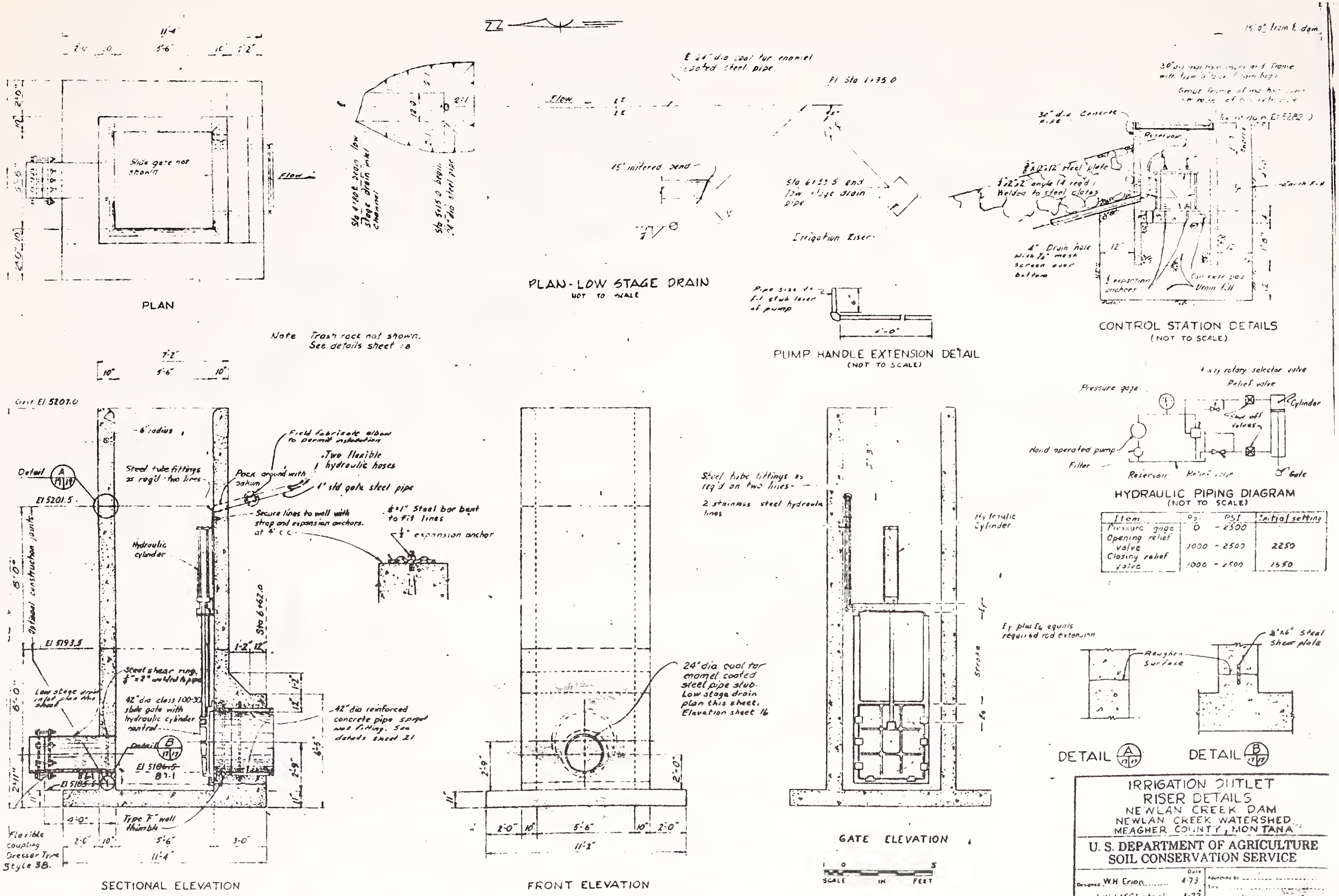
As-Built 7-18-77

IRRIGATION OUTLET
PROFILE AND CROSS SECTIONS
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W. H. Erion 4-73
Drawn ∕ A. Winters 4-73

EXHIBIT C1 - SHEET 6


PLAN
Slide gate not shown
Flow
11'-4"
5'-6"
2'-0"
10"
1'-2"
Sta 4+80.2 drain low stage drain inlet channel
Sta 5+15.0 begin 24" dia steel pipe
12.0
2:1
PLAN - LOW STAGE DRAIN
NOT TO SCALE
Flow
℄ 24" dia cool tar enamel coated steel pipe
15° mitered bend
PI Sta 6+35.0
Sta 6+53.5 end low stage drain pipe
Irrigation Riser
Pipe size to fit stub lever of pump
1'-0"
PUMP HANDLE EXTENSION DETAIL
(NOT TO SCALE)
15'-0" from ℄ dam
30" dia manhole cover and frame
Grout frame of manhole
30" dia Concrete pipe
Reservoir
8"x12"x12" steel plate
1"x2"x2" angle (4 req'd) welded to steel plates
4" Drain hole with 1/4" mesh screen over bottom
Expansion anchors
Concrete pad
Drain fill
Earth fill
12"
1'-8"
CONTROL STATION DETAILS
(NOT TO SCALE)
Note Trash rack not shown. See details sheet 18
7'-2"
10"
5'-6"
Crest El 5207.0
6" radius
Detail A 17/17
El 5201.5
Steel tube fittings as req'd - two lines
Field fabricate elbow to permit installation
Pack around with oakum
Two flexible hydraulic hoses
1" std galv steel pipe
Secure lines to wall with strap and expansion anchors at 4' c.c.
1/4"x1" Steel bar bent to fit lines
1/2" expansion anchor
Hydraulic cylinder
Optional construction joints
8'-0"
El 5193.5
Sta 6+62.0
1'-2"
12"
Steel shear ring 1/4"x2" welded to pipe
42" dia class 100-30 slide gate with hydraulic cylinder control
42" dia reinforced concrete pipe spigot and fitting. See details sheet 21
Low stage drain inlet plan this sheet
Detail B 17/17
El 5186.5
El 5185.5
8'-0"
6'-5"
2'-9"
2'-11"
11"
4'-0"
2'-6"
10"
5'-6"
3'-0"
11'-4"
Type "F" wall thimble
Flexible coupling Dresser Type Style 38.
SECTIONAL ELEVATION
24" dia cool tar enamel coated steel pipe stub. Low stage drain plan this sheet. Elevation sheet 16
2'-9"
2'-0"
11"
2'-0"
10"
5'-6"
10"
2'-0"
11'-2"
FRONT ELEVATION
Steel tube fittings as req'd on two lines
2 stainless steel hydraulic lines
Hydraulic Cylinder
Stroke
GATE ELEVATION
0
5
SCALE IN FEET
4 way rotary selector valve
Relief valve
Pressure gage
Cylinder
Shut off valves
Hand operated pump
Filter
Reservoir
Relief valve
Gate
HYDRAULIC PIPING DIAGRAM
(NOT TO SCALE)
E1 plus E2 equals required rod extension
Roughen Surface
1/4"x6" Steel Shear plate
DETAIL A 17/17
DETAIL B 17/17

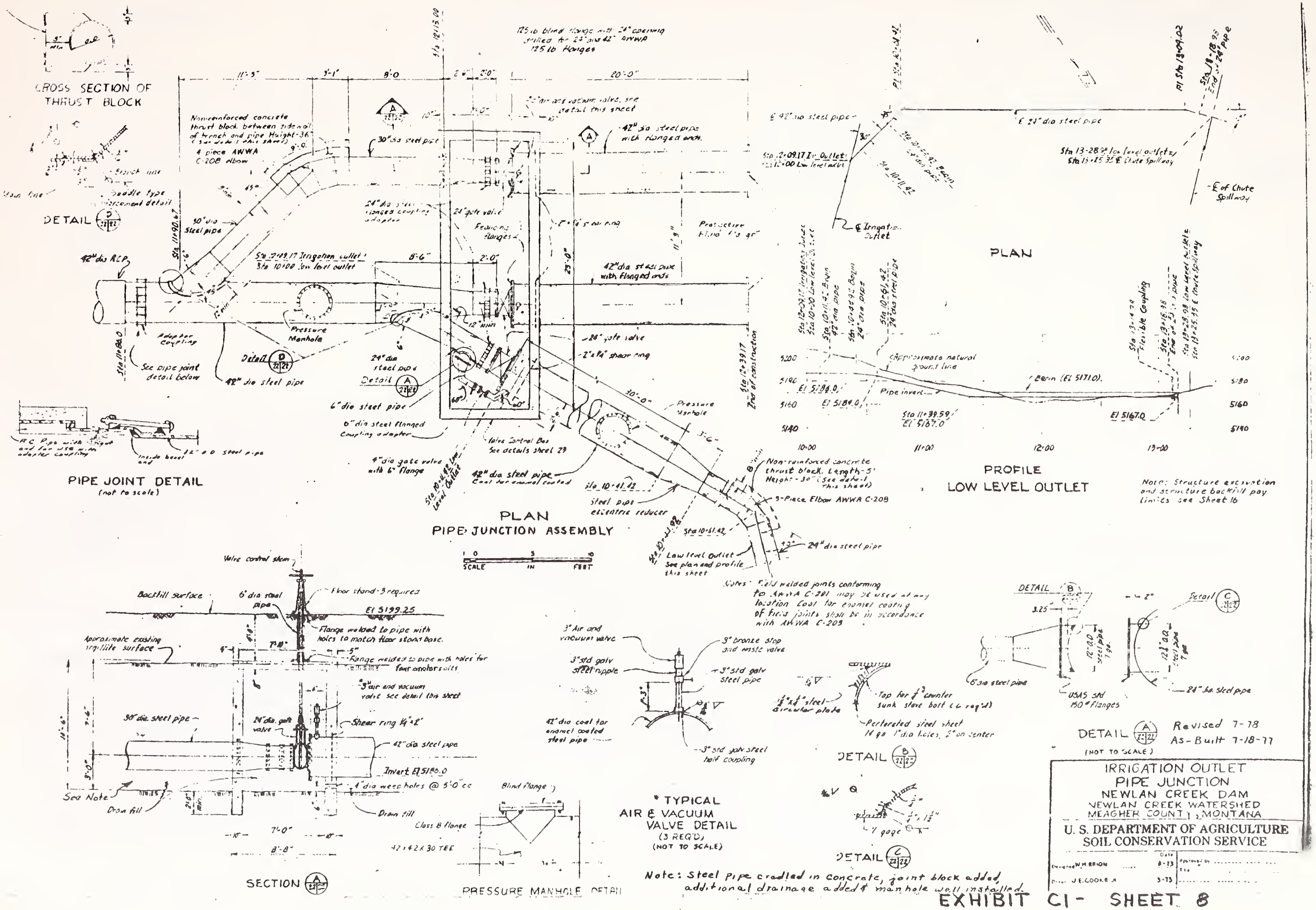
Item	PSI	Initial setting
Pressure gage	0 - 2500	
Opening relief valve	1000 - 2500	2250
Closing relief valve	1000 - 2500	1550

IRRIGATION OUTLET
RISER DETAILS
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	W.H Erion	4-73	Approved by
	LW McClintock	4-73	Title

EXHIBIT CI - SHEET 7


CROSS SECTION OF THRUST BLOCK
DETAIL D 22/22
PIPE JOINT DETAIL
(not to scale)
PLAN
PIPE JUNCTION ASSEMBLY
SCALE IN FEET
PLAN
PROFILE
LOW LEVEL OUTLET
Note: Structure excavation and structure backfill pay limits see Sheet 16
Notes: Field welded joints conforming to AWWA C-201 may be used at any location. Coal tar enamel coating of field joints shall be in accordance with AWWA C-203
SECTION A 22/22
PRESSURE MANHOLE DETAIL
* TYPICAL AIR & VACUUM VALVE DETAIL
(3 REQ'D)
(NOT TO SCALE)
DETAIL B 22/22
DETAIL C 22/22
DETAIL A 22/22
(NOT TO SCALE)
42" dia RCP
42" dia steel pipe
30" dia steel pipe
24" dia steel pipe
Pressure Manhole
Valve Control Box See details sheet 29
Non-reinforced concrete thrust block
4 piece AWWA C-208 elbow
5-Piece Elbow AWWA C-208
Sta 12+09.17 Irrigation outlet
Sta 10+00 low level outlet
Sta 12+39.17 End of construction
El 5199.25
Invert El 5186.0
Backfill surface
Valve control stem
Floor stand - 3 required

Revised 7-78

As-Built 7-18-77

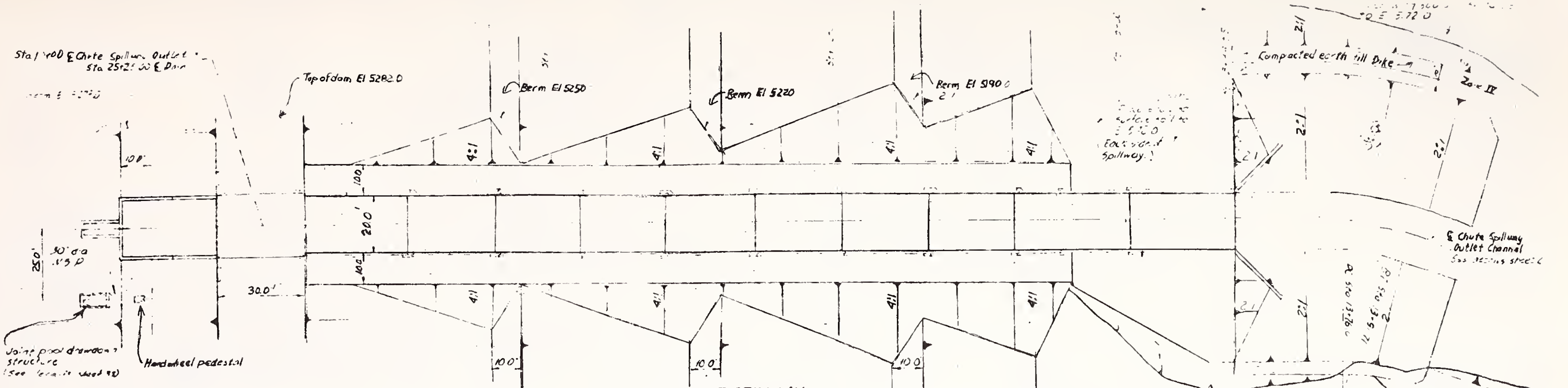
IRRIGATION OUTLET
PIPE JUNCTION
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W.H. ERION 8-73
Drawn J.E. COOKE Jr 3-73

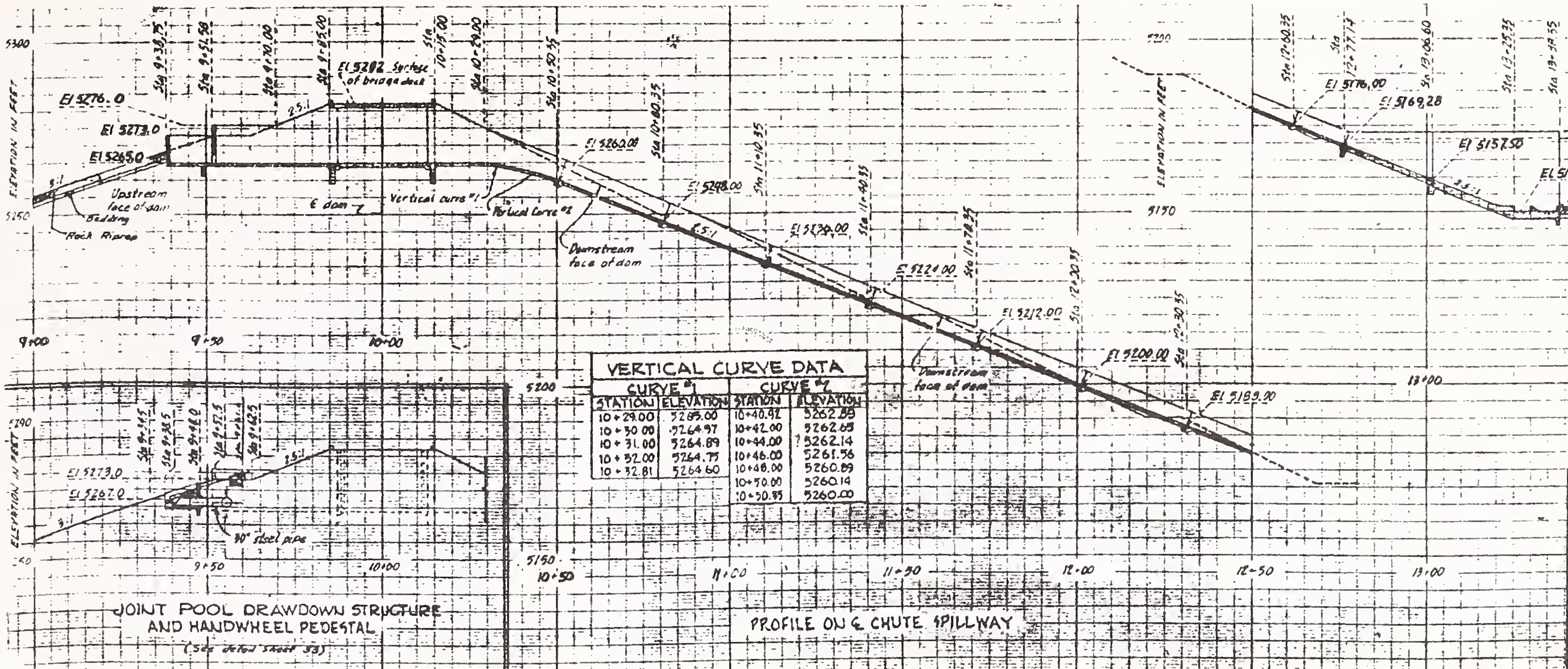
Note: Steel pipe cradled in concrete, joint block added, additional drainage added & manhole well installed.

EXHIBIT C1- SHEET 8



PLAN OF CHUTE SPILLWAY

10 0 50 FT



VERTICAL CURVE DATA			
CURVE #1		CURVE #2	
STATION	ELEVATION	STATION	ELEVATION
10+29.00	5265.00	10+40.92	5262.89
10+30.00	5264.97	10+42.00	5262.65
10+31.00	5264.89	10+44.00	5262.14
10+32.00	5264.75	10+46.00	5261.56
10+32.81	5264.60	10+48.00	5260.89
		10+50.00	5260.14
		10+50.85	5260.00

JOINT POOL DRAWDOWN STRUCTURE
AND HANDWHEEL PEDESTAL
(See detail sheet 33)

PROFILE ON ℄ CHUTE SPILLWAY

As-Built 7-18-77
No Change

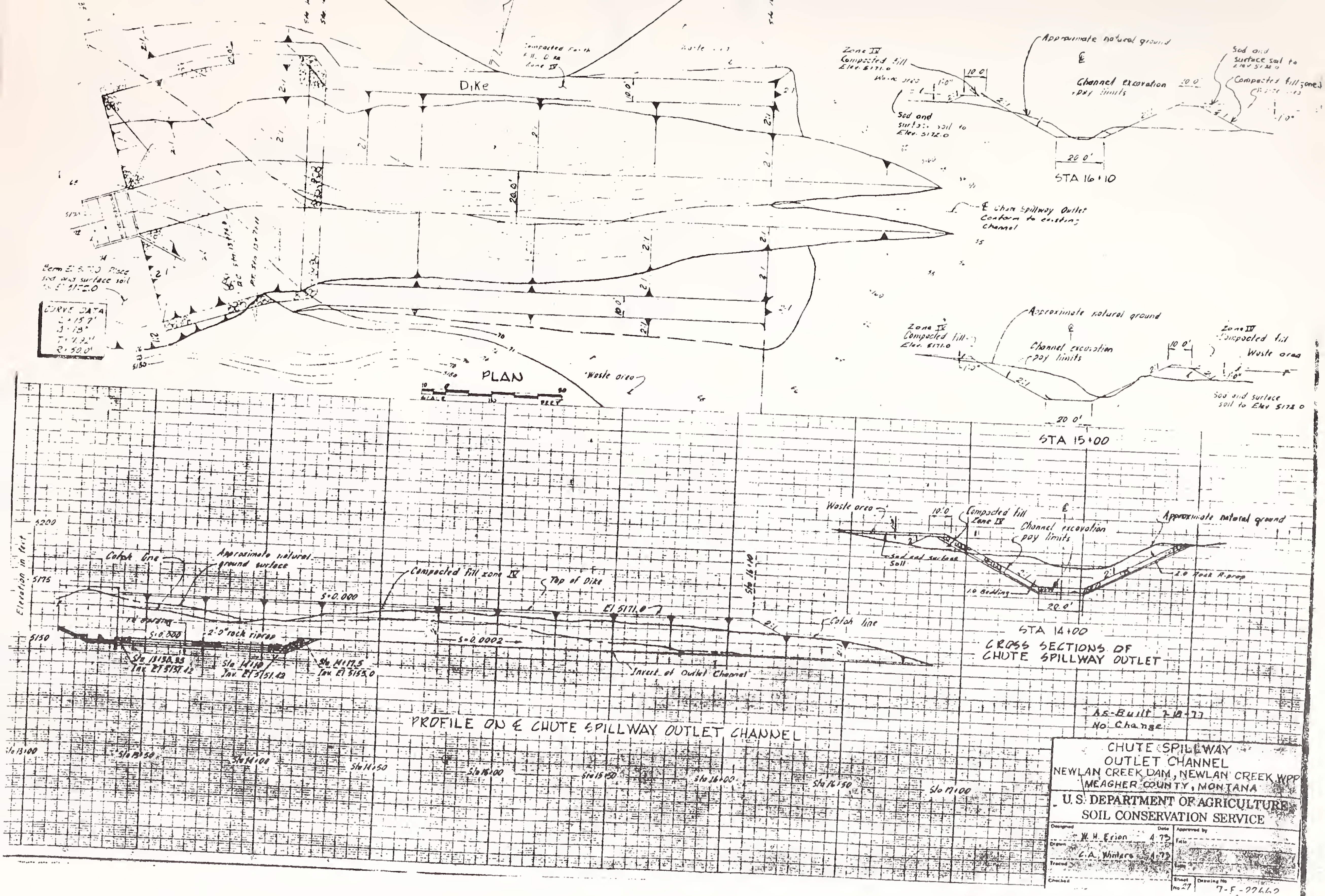
CHUTE SPILLWAY
PLAN AND PROFILE
NEWLAN CREEK DAM, NEWLAN CREEK WPP
MEAGHER COUNTY, MONTANA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W. H. Erinn	Date 3-73	Approved by
Drawn P. J. Clough	4-13	Title
Traced		Title
Checked		Sheet 26 / Drawing No.

EXHIBIT C1 - SHEET 9

Note: Principal Spillway Crest Elevations Field Measured .5' lower than shown on these drawings (6/26/80)


Dike
Compacted Earth Fill, Dike Zone IV
Waste area
Berm El. 5170.0 Place sod and surface soil to El. 5172.0
CURVE DATA
Δ=15°7'
D=18°
T=4.92'
R=50.0'
PC Sta 13+19.50
PT Sta 13+71.11
PLAN
SCALE
FEET
℄ Chute Spillway Outlet Conform to existing channel
Zone IV Compacted fill Elev. 5171.0
Sod and surface soil to Elev. 5172.0
Approximate natural ground
Channel excavation pay limits
Sod and surface soil to Elev. 5172.0
Compacted fill zones
STA 16+10
Zone IV Compacted fill Elev. 5171.0
Approximate natural ground
Channel excavation pay limits
Zone IV Compacted fill
Waste area
Sod and surface soil to Elev. 5172.0
STA 15+00
Waste area
Compacted fill Zone IV
Channel excavation pay limits
Approximate natural ground
Sod and surface Soil
1.0 Bedding
2.0 Rock Riprap
STA 14+00
CROSS SECTIONS OF CHUTE SPILLWAY OUTLET
Elevation in feet
5200
5175
5150
Catch line
Approximate natural ground surface
Compacted fill zone IV
Top of Dike
S=0.000
El 5171.0
S=0.0002
Catch line
1.0 Bedding
2.0" rock riprap
Sta 13+30.95 Inv. El 5151.42
Sta 14+10 Inv. El 5151.42
Sta 14+17.5 Inv. El 5155.0
Invert of Outlet Channel
Sta 16+10
PROFILE ON ℄ CHUTE SPILLWAY OUTLET CHANNEL
Sta 13+00
Sta 13+50
Sta 14+00
Sta 14+50
Sta 15+00
Sta 15+50
Sta 16+00
Sta 16+50
Sta 17+00

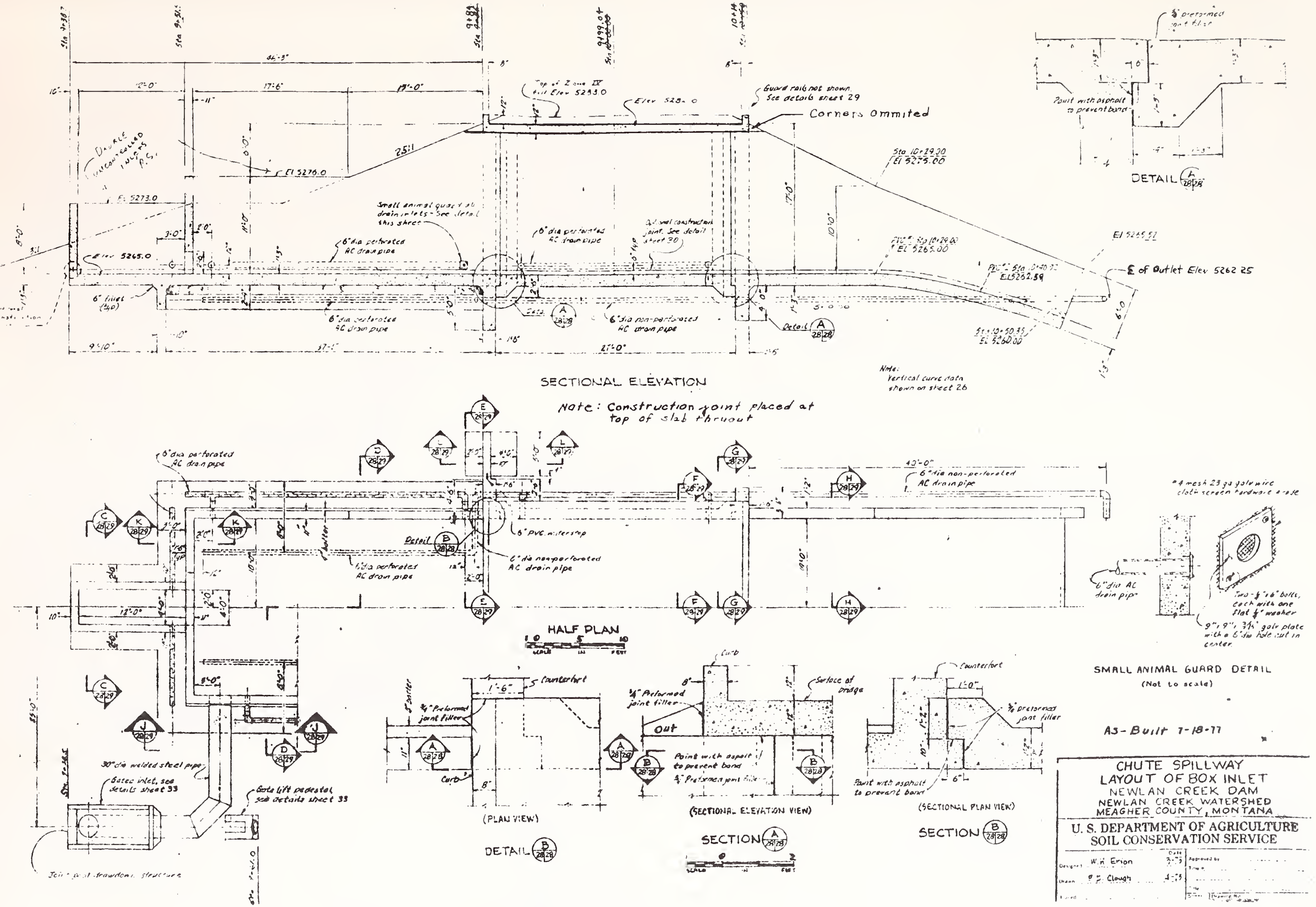
As-Built 7-18-77
No Change

CHUTE SPILLWAY
OUTLET CHANNEL
NEWLAN CREEK DAM, NEWLAN CREEK WPP
MEAGHER COUNTY, MONTANA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
W. H. Erion	4-73	Title
Drawn		
C.A. Winters	4-73	
Traced		
Checked		
	Sheet No 27	Drawing No 7-E-22462

EXHIBIT C1- SHEET 10


Sta 9+38.7
Sta 9+51.5
Sta 9+89
Sta 9+99.04
Sta 10+14
46'-9"
12'-0"
17'-6"
19'-0"
Top of Zone IV fill Elev 5283.0
Elev 528_.0
Guard rails not shown. See details sheet 29
Corners Ommited
DOUBLE UNCONTROLLED INLETS P.S.
2.5:1
El 5276.0
El 5273.0
Elev 5265.0
3:1
6" fillet (3/4 0)
Small animal guard at drain inlets - See detail this sheet
6" dia perforated AC drain pipe
6" dia perforated AC drain pipe
Dowel construction joint. See detail sheet 30
6" dia non-perforated AC drain pipe
Detail A 28/28
Sta 10+29.00 El 5275.00
PVC Sta 10+29.00 El 5265.00
PVT Sta 10+40.92 El 5262.59
El 5265.52
℄ of Outlet Elev 5262.25
Sta 10+50.35 El 5260.00
Note: Vertical curve data shown on sheet 26
9'-10"
37'-_"
27'-0"
SECTIONAL ELEVATION
Note: Construction joint placed at top of slab thruout
6" dia perforated AC drain pipe
6" dia non-perforated AC drain pipe
6" PVC waterstop
6" dia non-perforated AC drain pipe
6" dia perforated AC drain pipe
Detail B 28/28
40'-0"
12'-0"
HALF PLAN
30" dia welded steel pipe
Gated inlet, see details sheet 33
Gate lift pedestal see details sheet 33
Join to ..l drawdown structure
5 Counterfort
1'-6"
¾" Preformed joint filler
Curb
(PLAN VIEW)
DETAIL B 28/28
Curb
¾" Preformed joint filler
Out
Surface of bridge
Point with asphalt to prevent bond
¾" Preformed joint filler
(SECTIONAL ELEVATION VIEW)
SECTION A 28/28
Counterfort
¾" preformed joint filler
Point with asphalt to prevent bond
(SECTIONAL PLAN VIEW)
SECTION B 28/28
¾" preformed joint filler
Point with asphalt to prevent bond
DETAIL A 28/28
#4 mesh 23 ga galv wire cloth screen hardware ...
6" dia AC drain pipe
Two ¼" x 6" bolts, each with one flat ¼" washer
9" x 9" x 3/16" galv plate with a 6" dia hole cut in center
SMALL ANIMAL GUARD DETAIL
(Not to scale)

As-Built 7-18-77

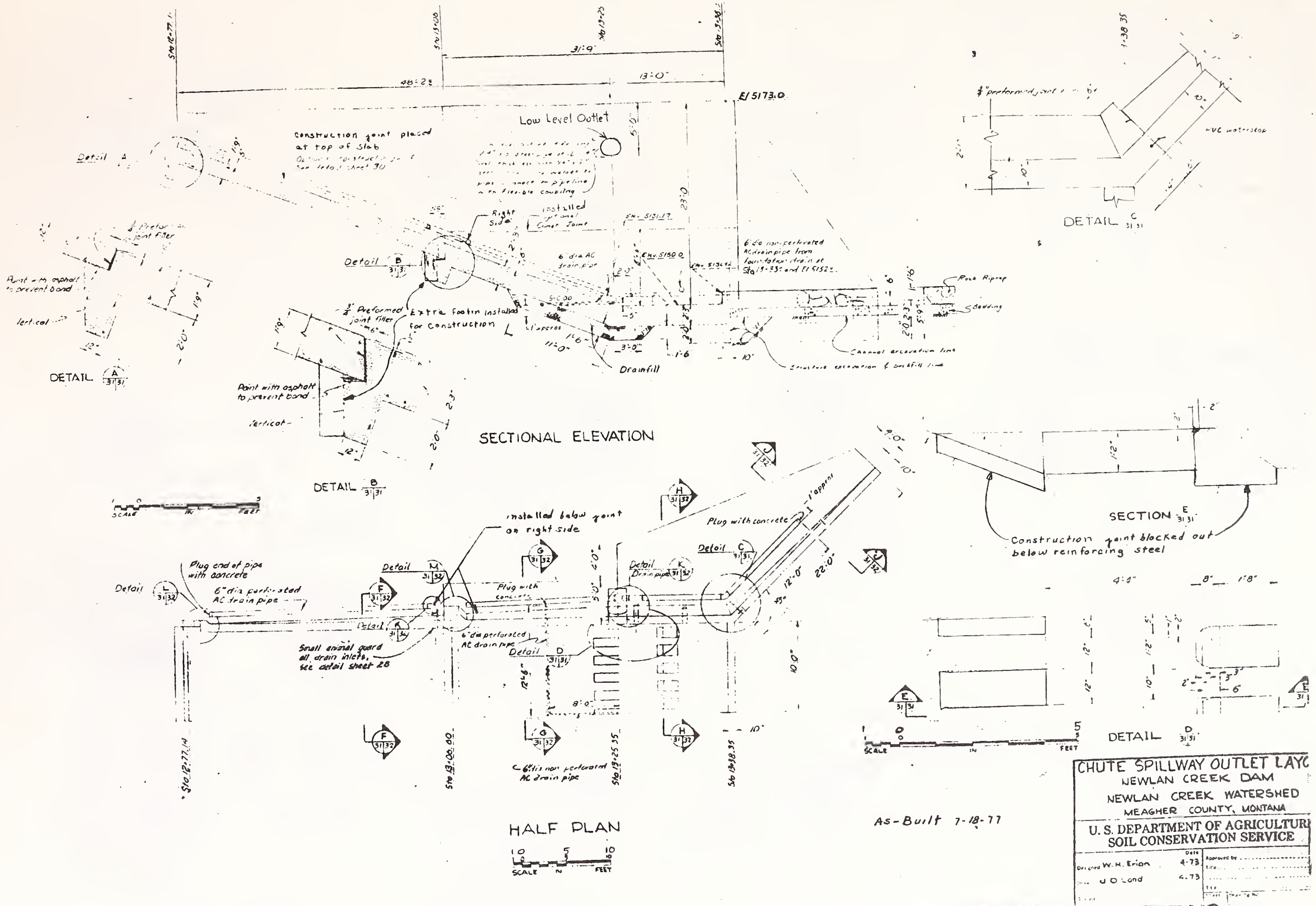
CHUTE SPILLWAY
LAYOUT OF BOX INLET
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W.R. Erion 3-75
Drawn P.F. Clough 4-75
Approved by

Note: Principal Spillway Crest Elevations field measured .5' lower than shown on these drawings (6/26/80)

EXHIBIT C1- SHEET 11

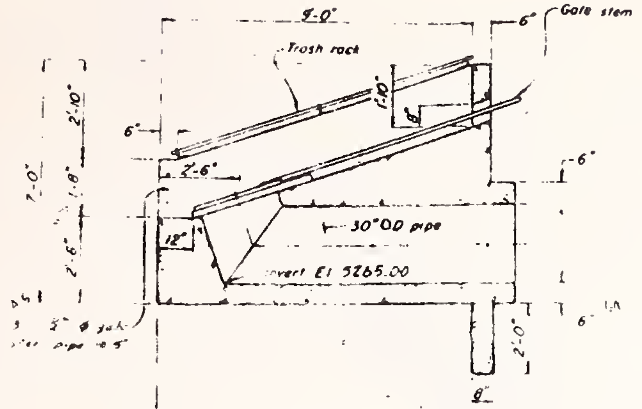

Sta 12+77.1
Sta 13+00
Sta 13+25
Sta 13+38.35
48'-2½"
31'-9"
13'-0"
El 5173.0
Low Level Outlet
Construction joint placed at top of slab
Installed optional Const. Joint
Right Side
El. 5151.17
El. 5150.0
6" dia AC drain pipe
6" dia non-perforated AC drain pipe from foundation drain at Sta 13+35± and El 5152±
23'-0"
5'-0"
Rock Riprap
Bedding
Channel excavation line
Structure excavation & backfill line
Drainfill
Extra footin installed for construction
¾" Preformed joint filler
Detail B 31|31
Detail A
Point with asphalt to prevent bond
Vertical
SECTIONAL ELEVATION
DETAIL A 31|31
DETAIL B 31|31
DETAIL C 31|31
¾" preformed joint filler
PVC waterstop
SECTION E 31|31
Construction joint blocked out below reinforcing steel
DETAIL D 31|31
installed below joint on right side
Plug with concrete
Plug end of pipe with concrete
6" dia perforated AC drain pipe
Small animal guard all drain inlets, see detail sheet 28
6" dia perforated AC drain pipe
6" dia non perforated AC drain pipe
Detail L 31|32
Detail M 31|32
Detail K 31|34
Detail D 31|31
Detail C 31|31
Detail Drain pipe K 31|32
F 31|32
G 31|32
H 31|32
J 31|32
E 31|31
1' approx
12'-0"
22'-0"
45°
10'-0"
8'-0"
HALF PLAN
SCALE FEET
As-Built 7-18-77

CHUTE SPILLWAY OUTLET LAY
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

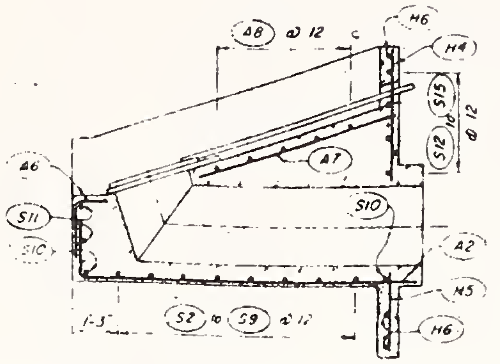
U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE

	Date	
Designed W. H. Erion	4-73	Approved by
J O Lond	4-73	Title

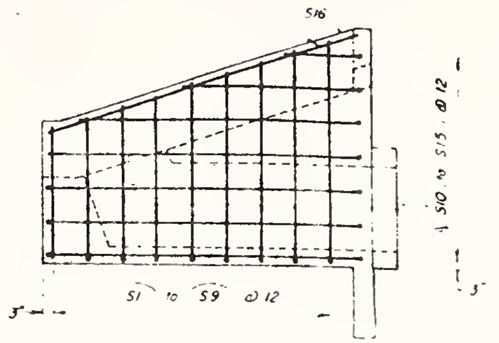
EXHIBIT C1 - SHEET 12



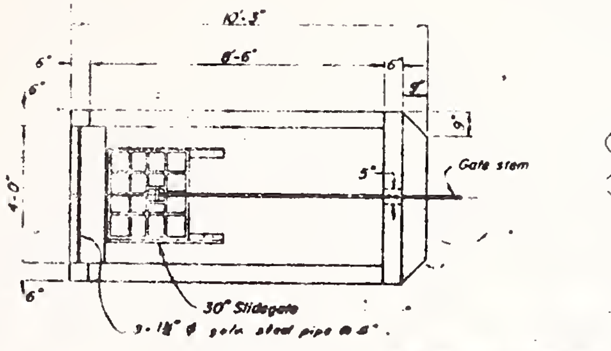
SECTIONAL ELEVATION



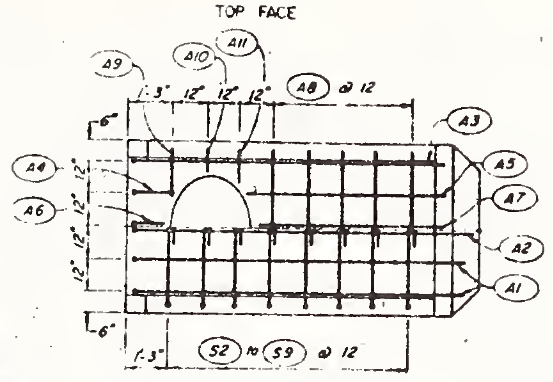
SECTIONAL ELEVATION



SIDEWALL ELEVATION



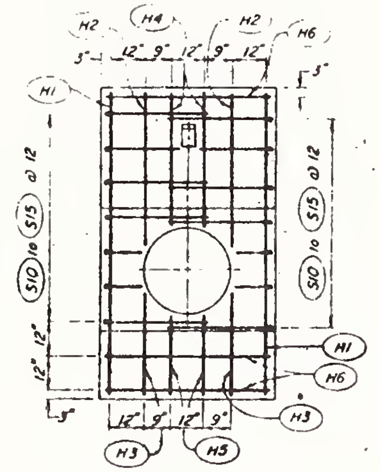
PLAN



BOTTOM FACE

PLAN

INLET STRUCTURE

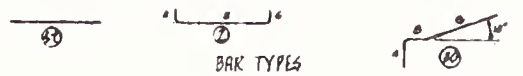


HEADWALL ELEVATION

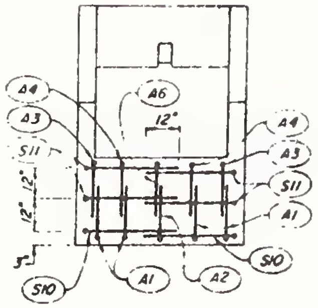
Location	Mark	Size	Quan	Length	Type	A	B	G	Total Length
Apron	A1	4	4	11'-0"	2	1'-6"	9'-6"		44'-0"
"	A2	4	1	11'-3"	2	1'-6"	9'-9"		11'-3"
"	A3	4	2	10'-9"	30	1'-6"	9"	8'-6"	21'-6"
"	A4	4	2	2'-3"	2	1'-6"	9"		4'-6"
"	A5	4	2	5'-9"	S1				11'-6"
"	A6	4	1	2'-0"	2	1'-6"	6"		2'-0"
"	A7	4	1	5'-3"	S1				5'-3"
"	A8	4	5	4'-6"	S1				22'-6"
"	A9	4	2	1'-3"	S1				2'-6"
"	A10	4	2	9"	S1				1'-6"
"	A11	4	2	1'-0"	S1				2'-0"
Sidewall	S1	4	2	3'-9"	S1				7'-6"
"	S2	4	2	6'-9"	2	2'-9"	4'-0"		13'-6"
"	S3	4	2	7'-0"	2	2'-9"	4'-3"		14'-0"
"	S4	4	2	7'-3"	2	2'-9"	4'-6"		14'-6"
"	S5	4	2	7'-9"	2	2'-9"	5'-0"		15'-6"
"	S6	4	2	8'-0"	2	2'-9"	5'-3"		16'-0"
"	S7	4	2	8'-3"	2	2'-9"	5'-6"		16'-6"
"	S8	4	2	8'-9"	2	2'-9"	6'-0"		17'-6"
"	S9	4	2	9'-0"	2	2'-9"	6'-3"		18'-0"
"	S10	4	2	14'-6"	2	2'-9"	9'-0"	2'-9"	29'-0"
"	S11	4	4	12'-6"	2	2'-9"	9'-0"	9"	50'-0"
"	S12	4	2	11'-9"	2	2'-9"	9'-0"		23'-6"
"	S13	4	2	10'-9"	2	2'-9"	8'-0"		21'-6"
"	S14	4	2	6'-9"	2	1'-9"	5'-0"		13'-6"
"	S15	4	2	4'-9"	2	2'-9"	2'-0"		9'-6"
"	S16	4	2	9'-3"	S1				18'-6"
Headwall	H1	4	2	8'-6"	S1				17'-0"
"	H2	4	2	4'-3"	S1				8'-6"
"	H3	4	2	2'-9"	S1				5'-6"
"	H4	4	2	3'-6"	S1				7'-0"
"	H5	4	2	2'-0	S1				4'-0
"	H6	4	3	4'-3"	S1				12'-9"

GATE LIFT PEDESTAL STEEL SCHEDULE

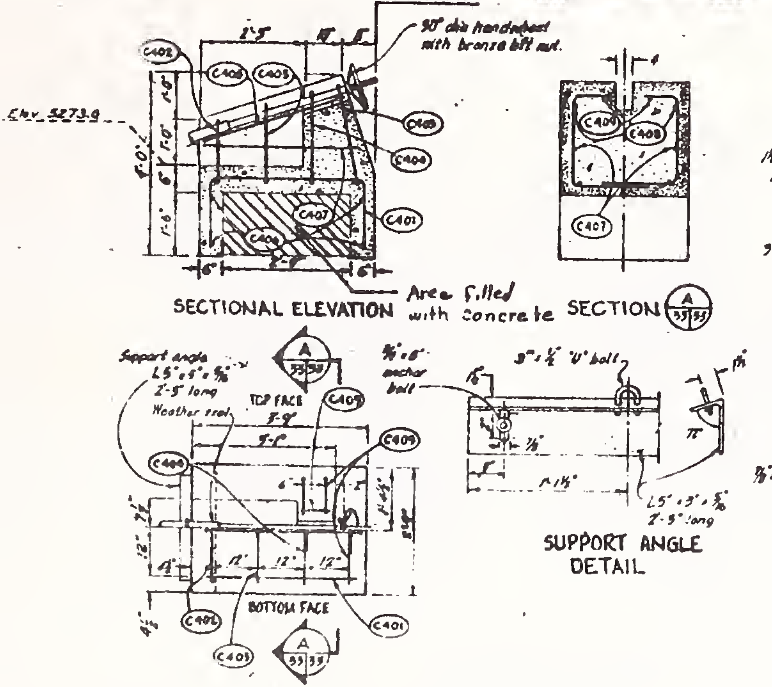
Location	Mark	Size	Quan	Length	Type	A	B	G	Total Length
Cutoff	C401	4	3	6'-3"	2	1'-6"	3'-3"	1'-6"	18'-9"
Sidewall	C402	4	1	4'-6"	2	1'-2"	2'-2"	1'-2"	4'-6"
"	C403	4	1	5'-0"	2	1'-9"	2'-2"	1'-5"	5'-0"
"	C404	4	2	4'-0"	2	1'-6"	1'-9"	0'-9"	8'-0"
"	C405	4	2	4'-3"	2	1'-6	2'-0"	0'-9"	8'-6"
Cutoff	C406	4	4	2'-3"	S1				9'-0"
Sidewall	C407	4	2	3'-0"	S1				6'-0"
"	C408	4	2	2'-9"	S1				5'-6"
"	C409	4	2	0'-6"	S1				1'-0"



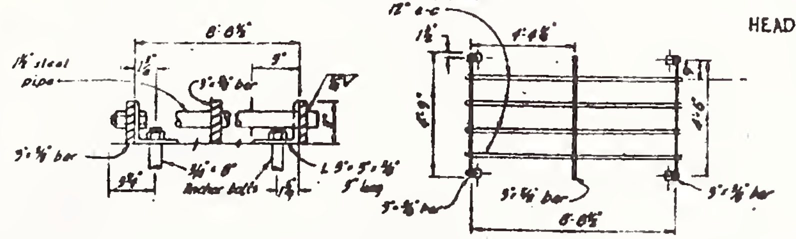
BAR TYPES



UPSTREAM ELEVATION



GATE LIFT PEDESTAL



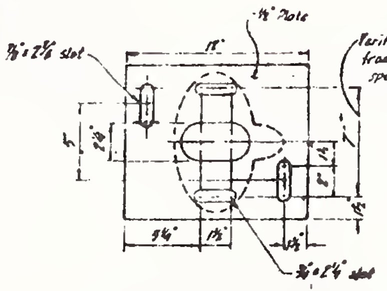
TRASH RACK DETAILS

(NOT TO SCALE)

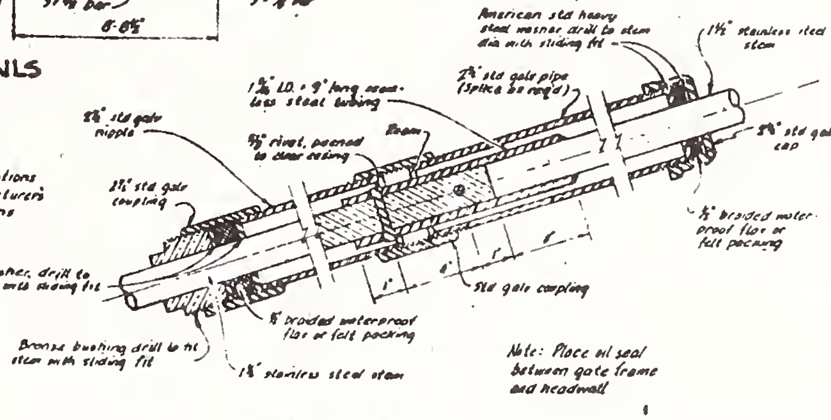
Note:

Fill with SAE 80 motor oil approximately 9 gallons.

Place neoprene seal above riprapped section clear of control structure



HANDWHEEL BASE PLATE DETAIL


American std heavy steel washer drill to stem dia with sliding fit
1½" stainless steel stem
1⅞" I.D. × 9" long seamless steel tubing
2½" std galv pipe (Splice as req'd)
2½" std galv nipple
⅜" rivet, peened to clear casing
2½" std galv coupling
2½" std galv cap
½" braided waterproof flax or felt packing
Steel washer, drill to fit stem with sliding fit
Std galv coupling
½" braided waterproof flax or felt packing
Bronze bushing drill to fit stem with sliding fit
1½" stainless steel stem
Note: Place oil seal between gate frame and headwall

GATE STEM SPLICE

As-Built 7-18-77

INLET STRUCTURE 7-E-20465 SIZE I

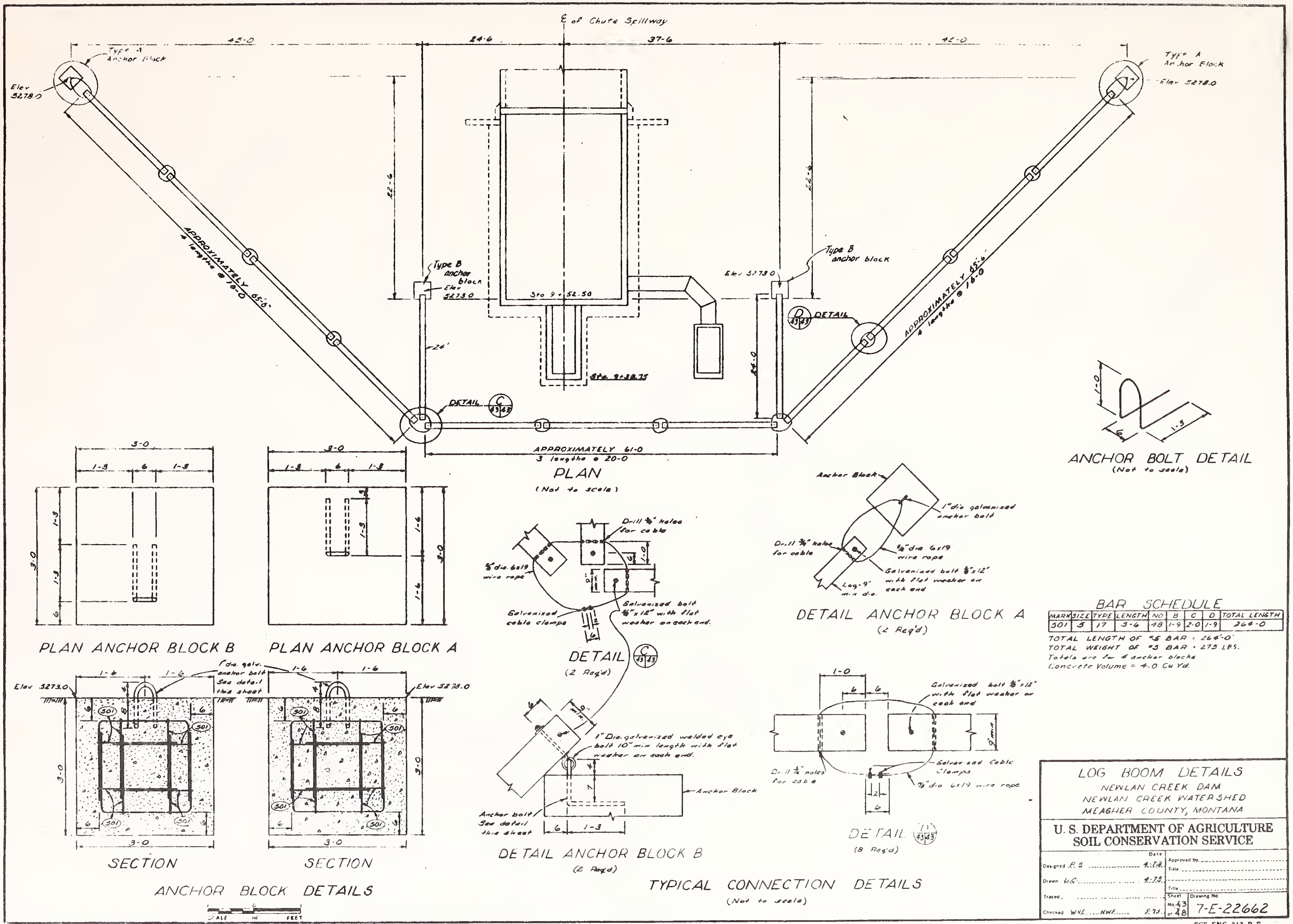
E & WP UNIT PORTLAND OREGON

JOINT POOL DRAWDOWN STRUCTURE
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	W.H. Erian	9-73	Approved by
Drawn	R.D. Clough	5-75	Title
Traced			Sheet / Drawing No.

EXHIBIT C1- SHEET 13



BAR SCHEDULE

MARK	SIZE	TYPE	LENGTH	NO	B	C	D	TOTAL LENGTH
501	5	17	5-6	48	1-9	2-0	1-9	264-0

TOTAL LENGTH OF #5 BAR = 264'-0"
TOTAL WEIGHT OF #5 BAR = 275 LBS.
Totals are for 4 anchor blocks
Concrete Volume = 4.0 Cu Yd.

LOG BOOM DETAILS
NEWLAN CREEK DAM
NEWLAN CREEK WATERSHED
MEAGHER COUNTY, MONTANA

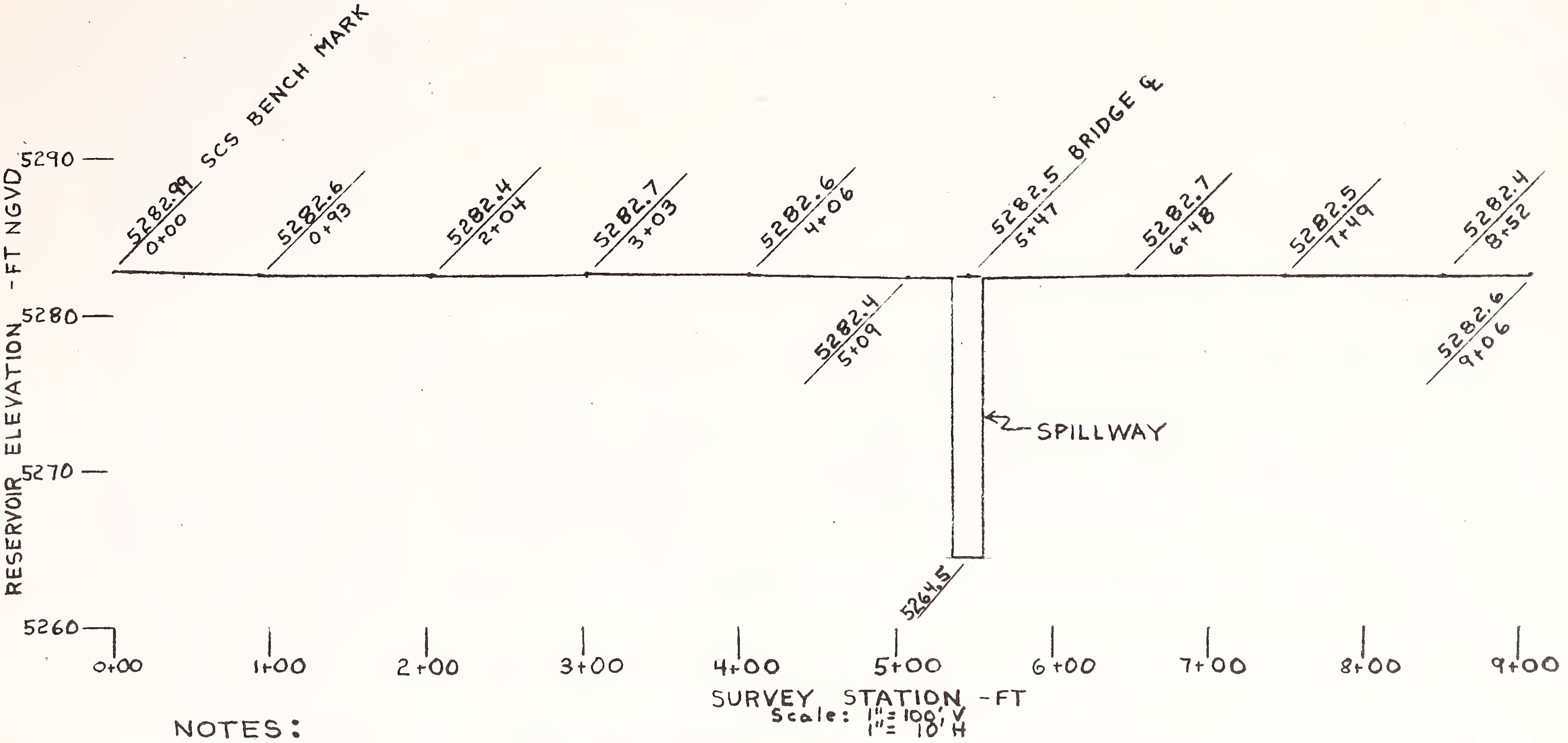
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed R.S.	4-73	Approved by
Drawn L.C.	4-73	Title
Traced		Title
Checked WHE ... HWF	5-73	Sheet No. 43 of 48 — Drawing No 7-E-22662

SCS-ENG 313

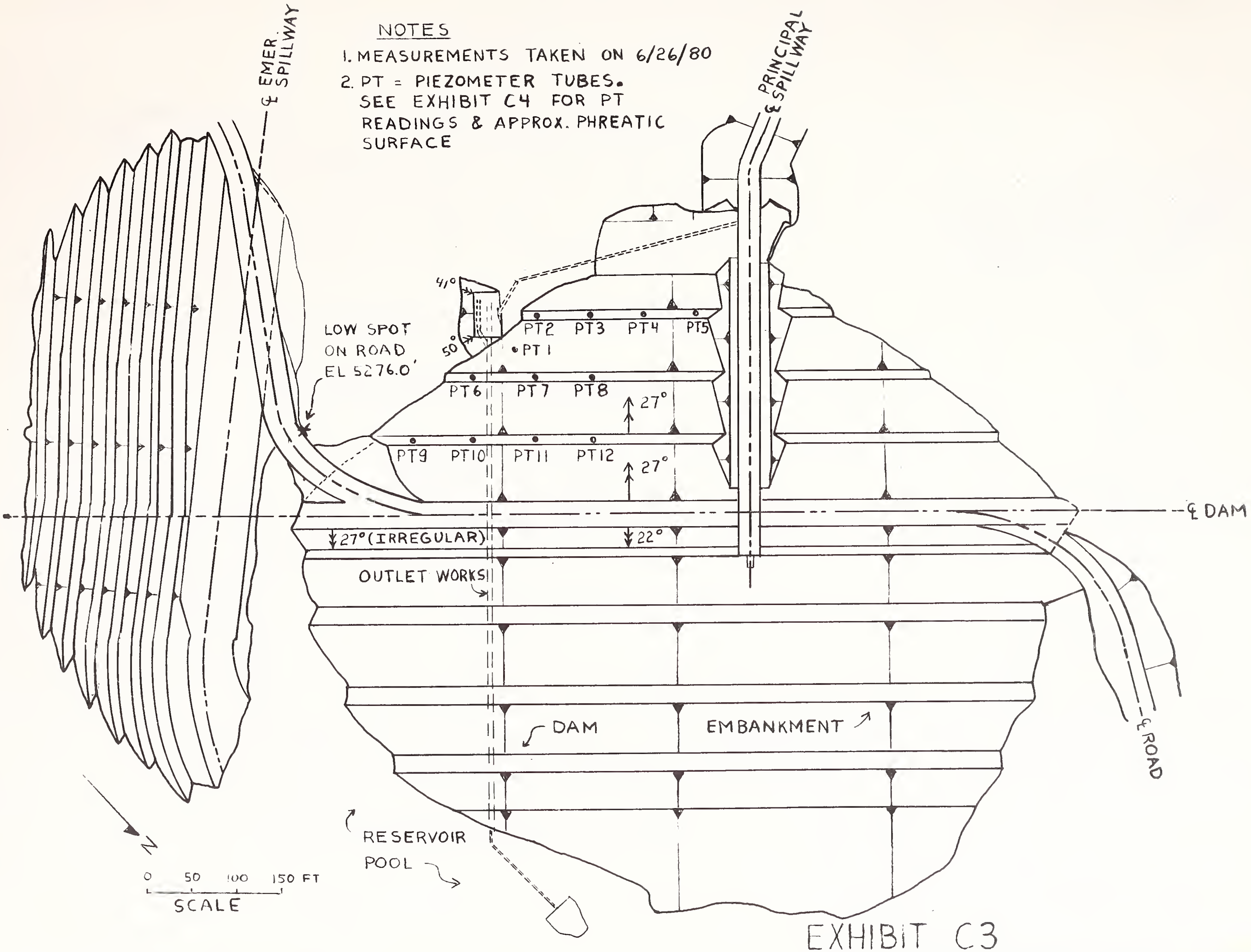
EXHIBIT C1- SHEET 14

EXHIBIT C2
DAM CREST SURVEY
NEWLAN CREEK DAM



NOTES:

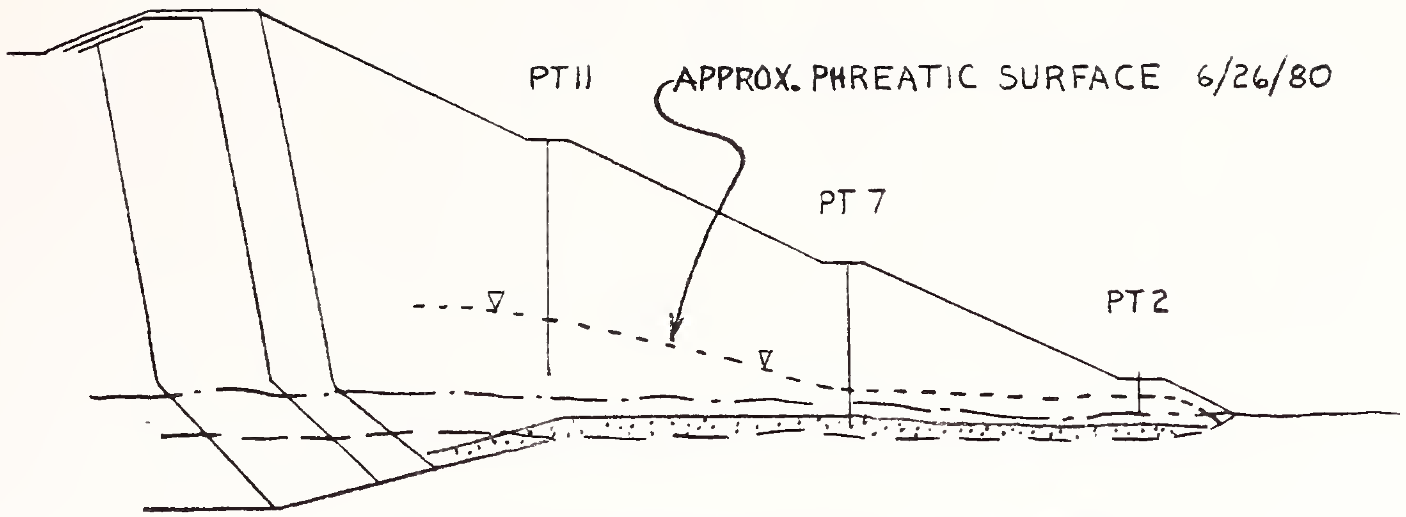
1. ALL STATIONS & ELEVATIONS FROM
   A FIELD SURVEY ON 6/26/80
2. ELEVATIONS BASED ON SCS BENCHMARK
   NEAR LEFT ABUTMENT EL. 5282.99 FT NGVD
3. LOW SPOT ON ROAD OFF ℄ DAM AXIS = EL. 5276.0
   FT NGVD (SEE EXHIBIT C3 FOR LOCATION)
4. EMERGENCY SPILLWAY CREST EL. 5278.3 FT NGVD



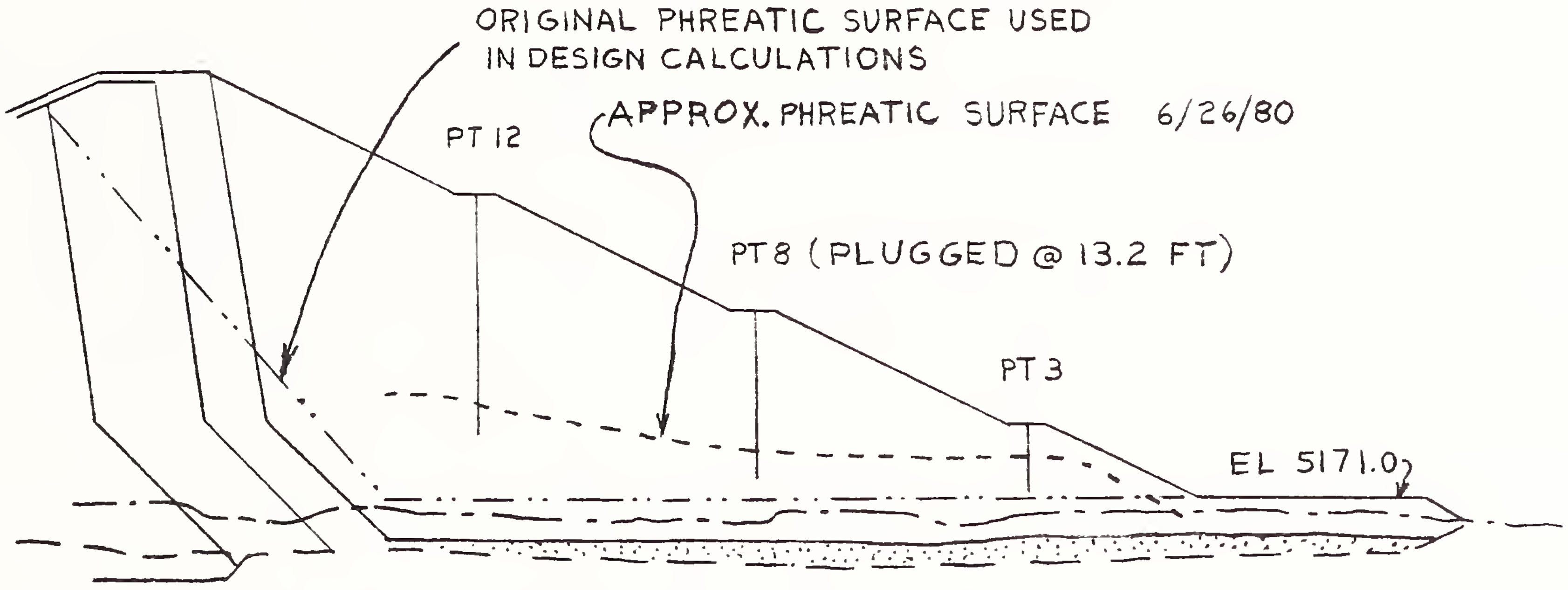
NOTES

1. MEASUREMENTS TAKEN ON 6/26/80
2. PT = PIEZOMETER TUBES. SEE EXHIBIT C4 FOR PT READINGS & APPROX. PHREATIC SURFACE

EXHIBIT C3
MEASURED EMBANKMENT SLOPES
NEWLAN CREEK DAM



SECTION THROUGH PT 11 - PT7 - PT 2


ORIGINAL PHREATIC SURFACE USED IN DESIGN CALCULATIONS
APPROX. PHREATIC SURFACE 6/26/80
PT 12
PT 8 (PLUGGED @ 13.2 FT)
PT 3
EL 5171.0

SECTION THROUGH PT 12 - PT 8 - PT 3

SCALE: 1" = 60'

PIEZOMETER TUBE NO. (PT)	WATER DEPTH BELOW EMBANKMENT SURFACE (FT.)
1	15.7
2	4.7
3	9.0
4	18.5
5	17.3
6	26.8
7	30.4
8	No Water - Bottom @ 13.2 FT
9	28.4
10	44.2
11	43.5
12	53.5

SEE EXHIBIT C3 FOR PT LOCATIONS

NOTES:

1. MEASUREMENTS TAKEN ON 6/26/80
2. RESERVOIR POOL EL. ON 6/26/80 = 5264.5 FT NGVD

EXHIBIT C4

PIEZOMETER READINGS & APPROX. PHREATIC SURFACE

NEWLAN CREEK DAM

EXHIBIT C5
SOIL DESIGN DATA
NEWLAN CREEK DAM

The soils properties assigned to the various zones and used in the analysis are:

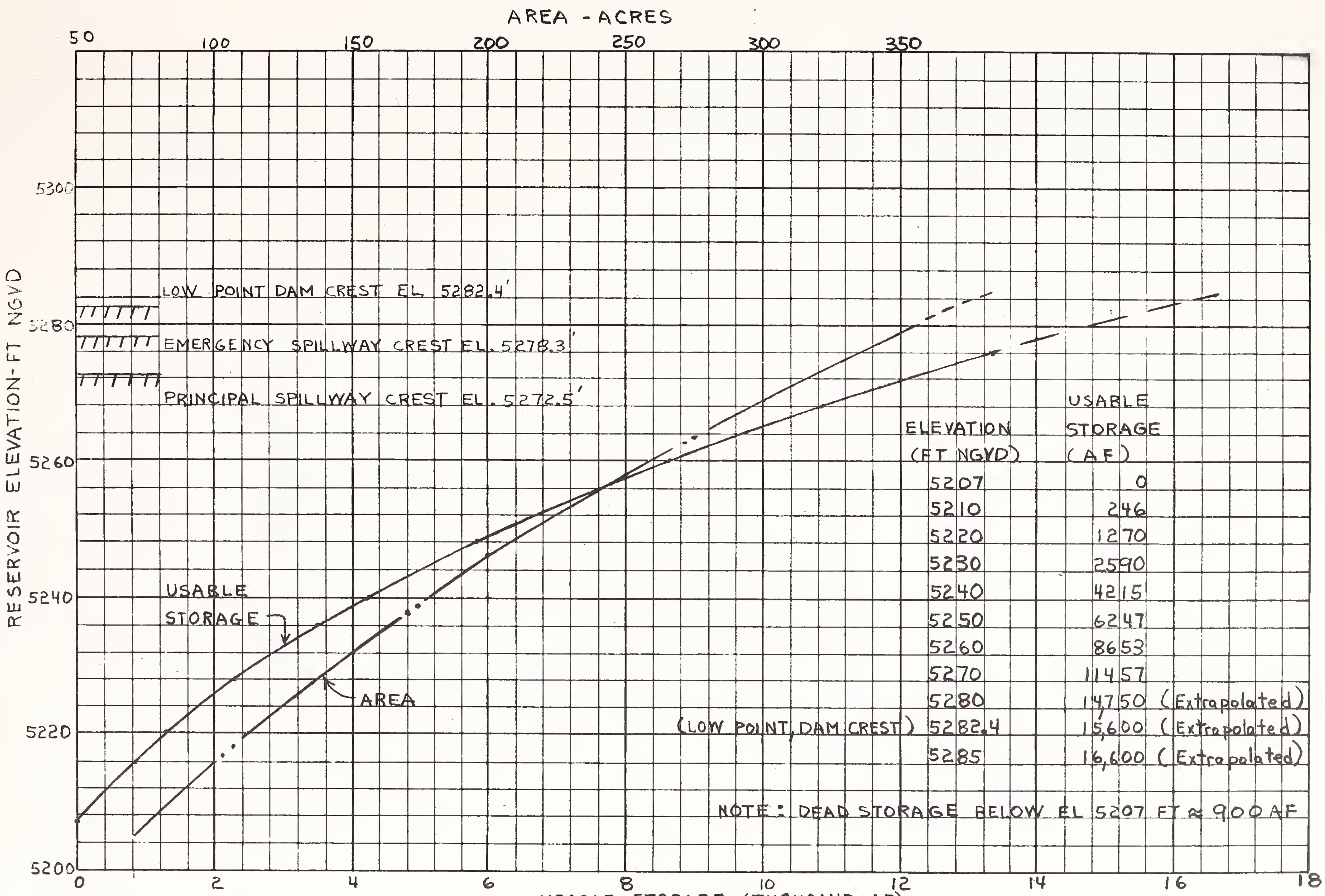
ZONE	ϕ (degrees)	W (%)	C (psf)	γ_d (pcf)	γ_m (pcf)	γ_{buoy} (pcf)	γ_{sat} (pcf)
I (CL-1)	18	16	300	107	124	67.2	129.6
II (GM-GC-SC)	25	10	400	120	132	75.6	138
III (GW)	28	6	150	115	121.9	72.4	134.8
IV Rock Fill (Argillite)	35	7	0	120	128.5	75.5	137.9
V Quartzite	35	7	0	120	128.5	75.5	--
VI (Foundation) Natural Rock	35	3.1	800	150	154.5	92.3	154.7
VII (Riprap)	35	--	0	---	140.4	--	---
VIII (Natural Ground)	18	16	200	107	124	62.5	124.9

Source: SCS Design Files

APPENDIX D

ENGINEERING DATA

Exhibit D1	Elevation-Area-Storage Curves
Exhibit D2	Discharge Rating Table
Exhibit D3	Discharge Rating Curves



ELEVATION (FT NGVD)	USABLE STORAGE (AF)	
5207	0	
5210	246	
5220	1270	
5230	2590	
5240	4215	
5250	6247	
5260	8653	
5270	11457	
5280	14750	(Extrapolated)
(LOW POINT, DAM CREST) 5282.4	15,600	(Extrapolated)
5285	16,600	(Extrapolated)

NOTE: DEAD STORAGE BELOW EL 5207 FT ≈ 900 AF

Source: SCS Design Files

EXHIBIT D1
ELEVATION-AREA-STORAGE CURVES
NEWLAN CREEK DAM

RESERVOIR ELEVATION (FT NGVD)		OUTLET WORKS DISCHARGE 1/ (CFS)	PRINCIPAL SPILLWAY DISCHARGE 2/ (CFS)	EMERGENCY SPILLWAY DISCHARGE 2/ (CFS)
5207	OUTLET WORKS RISER INLET	0	–	–
5210		65.0	–	–
5220		72.5	–	–
5230		79.3	–	–
5240		85.6	–	–
5250		91.4	–	–
5260		96.9	–	–
5270		102.0	–	–
5272.5	PRINCIPAL SPILLWAY CREST	103.3	0	–
5274		104.0	170	–
5276		105.3	190	–
5278		106	740	–
5278.3	EMERGENCY SPILLWAY CREST	106 3/	900	0
5280		107 3/	1890	290
5282		108 3/	3490	1140
5282.4	LOW POINT DAM CREST	108 3/	3870	1390

NOTES:

1/ Source = SCS Design Files
2/ Calculated independent from SCS
3/ Extrapolated values

EXHIBIT D2
DISCHARGE RATING TABLE
NEWLAN CREEK DAM

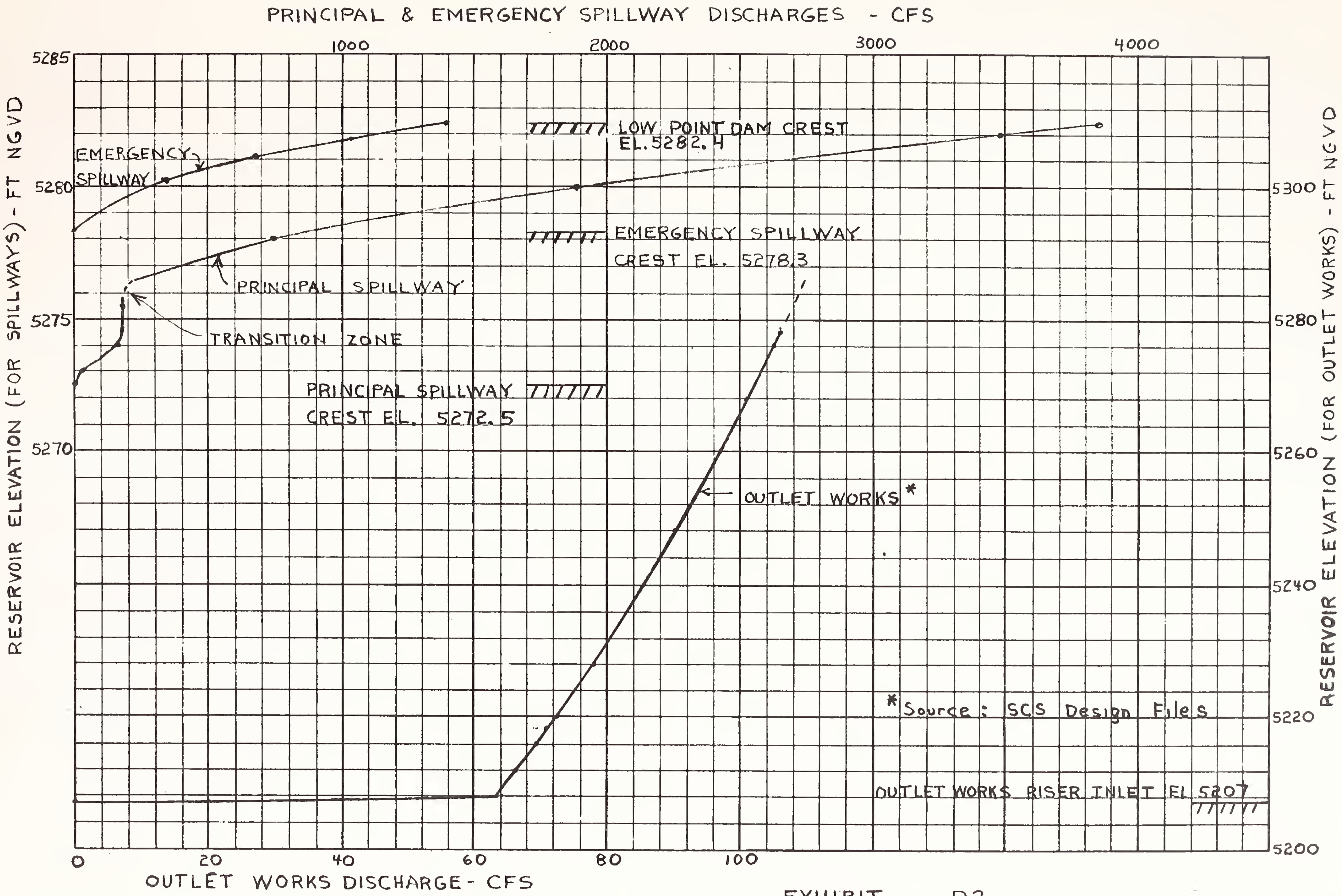


EXHIBIT D3
DISCHARGE RATING CURVES
NEWLAN CREEK DAM

APPENDIX E

CORRESPONDENCE

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

TED SCHWINDEN, GOVERNOR
32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872 ADMINISTRATOR
(406) 449-3962 WATER RIGHTS BUREAU
(406) 449-2872 WATER SCIENCES BUREAU
(406) 449-2864 ENGINEERING BUREAU
(406) 449-2872 WATER PLANNING BUREAU
HELENA, MONTANA 59620

RECEIVED
APR 3 1981

February 27, 1981

Ralph Morrison
Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Mr. Morrison:

The Department of Natural Resources reviewed the final draft report on the Newlan Creek Dam (MT-1596). We concur with the findings and recommendations and feel that the report satisfies the criteria for the Phase I evaluation.

Minor comments have been discussed with your staff, and we understand these will be included in the final report.

Thank you for the opportunity to review and comment on the final draft report on Newlan Creek Dam.

Sincerely,

Richard L Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau
(406) 449-2864

RB:LT:lj

"AN EQUAL OPPORTUNITY EMPLOYER"

United States
Department of
Agriculture

Soil
Conservation
Service

P.O. Box 970
Bozeman, MT
59715

March 19, 1981

[illegible] 1981

Sidney Knutson, P.E.
Assistant Chief
Engineering Division
Seattle District Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Dear Mt. Knutson:

Thank you for the opportunity to review the final draft report on Newlan Creek Dam (MT-1596).

Our comments relating to specific report statements are:

Page vii, line 19: This sentence on valve operation does not agree with line 12 on page 22 and line 3, page 55.

Page viii, line 10, page IX, line 3, Page 18 paragraph 2, page 42 paragraph 2, page 43,and page 56, item 9: Soil sloughing in the rock spillway was expected, that is the reason berms were installed. Soil and rock reaching the spillway channel should be removed during periodic maintenance. When the canals are completed, the outlet works will be extended 35 feet or more by installation of an expansion pipe and energy dissipator. Backfill and grading over the valve box and these additions will cover the sloughing slope.

Page viii, line 13, page 18 paragraph 2, and page 55 item 3: Access from the county road to the downstream berms for chute repairs has made an illusion of a low spot where spillway flows might "short circuit". Comparing the water surface profile through the spillway with a recent field survey of the road sections shows that there is greater than 3 feet of freeboard at the "low spot" when the reservoir is at the dam crest.

Page 6 line 11: Fort Logan is not a community but rather consists of a single uninhabited log blockhouse located next to a single farmstead. The buildings are 3/4 of a mile from and 60 feet above the Smith River.

Page 11, line 18 and page 48 line 14: This sentence should be changed to: "Repairs included cradling the irrigation outlet steel pipe manifold in concrete, adding a joint block to the 42 inch concrete pipe/steel pipe adapter coupler and flexible coupler, and installing additional drainage." A corrugated metal access riser was installed over the pressure manhole that was installed during the original construction.

Page 14 line 10: The box inlet and upper chute has tilted downstream during shell settlement, so the box crest is not level. Is this elevation based on one shot or is it an average elevation?

Page 14 line 22: The 30 inch diameter steel pipe is approximately 29 feet long rather than 7 feet.

Page 16 line 3: The SAF basin rock riprap is 2 feet thick.

Page 20 line 6: Change sentence to: "The pipe rests on a concrete cradle in contact with argillite bedrock. A portion of the pipe, as shown on Sheet 6, Exhibit C1, rests on a reinforced concrete cradle in contact with core trench fill."

Page 37 line 4 and third paragraph: All alluvial materials under the entire base of the dam were removed.

Page 38 line 18: Elevations were taken on several points of the chute on June 3, 1977 shortly after final construction. Elevations were taken 4 times between that date and September 26, 1979, at which time major repairs were undertaken.

Page 39, paragraph 2 & 3 and page 56 item 9: The SAF (stilling) basin wing walls have 27 inch thick footings resting on bedrock, thus settlement is not a reasonable assumption. The wing walls are designed and constructed to allow rotation and tilting independent of the basin. This is to allow the backfill to assume an active loading condition and to prevent moment transfer at the wing wall/basin joint. Moment transfer to the basin wall is not structurally desirable. Thus the wing walls are essentially an independent cantilever retaining wall whose movements are not unexpected nor unreasonable. The wing wall/basin joint contains a PVC waterstop.

Page 40: All drain pipe, perforated and nonperforated, is enveloped in drain fill designed to transmit a water flow equal to that of the pipe.

Page 48, line 5: May wish to add: "The joint use pool is to be held available for flood storage until May 1 unless stream flow forecasts on April 1 indicate little or no likelyhood of flow from snowmelt.

Page 55, item 4: The downstream shell of argillite, being quite sterile and well drained, does not provide a suitable seedbed for grass.

Page 54, item 2 and page 55, item 8: Arrangements are being made to repair the guardian gate and to improve access and use of the gate controls.

Exhibit D2: The rating table shows a principal (chute) spillway discharge of 3870 cfs at the dam crest. The SCS design calculations show the box inlet weir becoming submerged at approximately pool elevation 5280.7 (Q=2273) thus limiting the dam crest discharge to a maximum of approximately 2900 cfs.

General Comments:

-Using the Log Pearson III distribution, an estimate of the 10,000 year peak discharge was made from damsite gage data analysis. From 18 years of record on Newlan Creek at the damsite:

Mean of logs, M = 1.71174
Std. Dev. of logs, S = 0.297761
Station Skew, G_S = 0.82
Regional Skew, G_R = 0.25

	% Chance of Occurrence	Regional Skew = 0.25	Station Skew = 0.82
100 Year Peak	0.01	287 cfs	378 cfs
10,000 Year Peak	0.0001	955 cfs	2313 cfs

The present dam crest spillway capacity is 4300 cfs. Enlargement to the recommended 100,900 cfs capacity (0% change of occurrence) is simply not a reasonable level of protection.

-We do not feel the meteorologic and hydrologic conditions used to develop the PMF are realistic. The conditions and criteria selected attempt to eliminate the element of risk to a degree that is not reasonable or practical.

We request that the meteorologic and hydrologic assumptions and conditions be fully presented and justified in the report.

-The inhabitable structure nearest the dam is only intermittently occupied. The remaining two are occupied continuously. If someone were in the houses, if they were asleep, if they had no warning, and if the dam failed suddenly and completely, their lives would be in danger. A warning system has validity, yet storms not even approaching the PMP or dam overtopping would cause sufficient flooding to give due warning.

We urge that a breach flood routing and thus a substantiated hazard classification be made in the Phase I inspection. With such a brief field overview, general hydrologic modeling and a subjective hazard analysis, the report is forcing the, as yet unjustified, economic burden of a Phase II inspection on the dam owners.

Sincerely,

Van K Haderlie

Van K Haderlie
State Conservationist

cc:
Raymond J. Smith, State Conservation Engineer, SCS, Bozeman
Dave Jones, Environmental Engineer, SCS, Bozeman